

THE INNER WORKINGS & LONG-TERM IMPACTS
OF UNCONVENTIONAL OIL AND GAS DEVELOPMENT
IN THE BAKKEN SHALE FORMATION

by

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DEDICATION

To my research participants, thank you for your time, for hosting me, for answering my questions, and for giving me driving tours of your communities. Thank you for telling me your stories, even when they were hard, and troubling my assumptions. Thank you for teaching me about service and community ethic. The debt can never be fully repaid, but I look forward to trying.

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ABSTRACT

This dissertation argues that public infrastructure investments are a primary way in which communities subsidize unconventional oil and gas (UOG) development at the local level. Notably, these direct and indirect costs are often ignored in assessments of the UOG industry's distribution of costs and benefits. Natural resource extraction typically requires large capital investments from the public and private sectors, particularly in rural and remote geographies. This creates a risk of resource dependence as communities that over-accommodate industry may struggle with large municipal debts and/or underutilized facilities once industry leaves. While public infrastructure investments are typically assumed to mutually benefit the public and industry, the extent to which infrastructure benefits communities in the long run is unclear. UOG heightens these unknowns due to its volatility. UOG is a particularly infrastructure-dependent resource due to the industry's geographically dispersed nature and subsequent labor intensity. Yet, there is surprisingly limited research on the capacity of local governments to address the burdens of UOG development on public infrastructure and government services. This research addresses these knowledge gaps through a series of case studies on infrastructure investments that communities made during the boom in UOG in the Bakken Shale Formation (eastern Montana and western North Dakota, United States). It uses a mixed-methods approach, drawing on over 90 stakeholder interviews, document analyses, participant observations, and extensive field research. The findings suggest that communities in the Bakken struggled with infrastructure decisions due to the overwhelming pace, scale, and unpredictability of the UOG industry. Nonetheless, community leaders repeatedly demonstrated adaptability and innovation as they addressed the boom's challenges. This research demonstrates that infrastructure investments simultaneously reinforced and disrupted economic dependence on industry, illustrating the unpredictability and unruliness of the long-term impacts of UOG development at the local level. In the conclusion, the dissertation argues that unconventional oil and gas (UOG) development creates distinct geographies of production and distinct geographies of public finance.

CHAPTER ONE

INTRODUCTION

My dissertation is about the mundane. More precisely, my dissertation is about how the mundane becomes spectacle in a rural and remote geography characterized by extensive unconventional oil and gas (UOG) development. Located in the northern Great Plains, United States, the Bakken is a large geographic region in eastern Montana and western North Dakota that experienced a boom in UOG from 2006 to 2014. The boom prompted a surge in population, which in turn increased demands on public infrastructure and services. Consequently, local and state governments throughout the region have invested heavily in new and upgraded infrastructure, from water systems and roads to wastewater facilities, landfills, transmission lines, recreation centers, and more (Appendix A). In most geographies, these investments would be mundane. However, the magnitude, scope, and condensed timeframe of the Bakken's investments are extraordinary. These infrastructure projects were designed to accommodate and advance the region's industrial energy development while retaining workers, but – as demonstrated by this dissertation – their long-term consequences are fraught. By digging deeply into the nuts and bolts of UOG development and its infrastructural impacts, this dissertation investigates the often-overlooked inner workings and governance processes of communities that host industrial energy development.

The details of how an oil boom occurs and is sustained over time have critical implications for communities, as does the extent to which they are able to capture short-term benefits from resource extraction and transform them into long-term opportunities.

The goal of this dissertation is to shine a light on the processes that enable the UOG industry and their outcomes at the local and regional scales. This research is thus informed by and contributes to the multidisciplinary literatures on energy impacts, rural economic geography, community development, and infrastructure studies. It seeks to make the following contributions: (1) to draw attention to the Bakken, an under-researched resource periphery in the energy impacts literature, (2) to argue for increased research on the role of infrastructure investments in enabling energy development, particularly with regards to questions of resource dependence, and (3) to investigate the role of local and state governments in navigating the opportunities and constraints prompted by the UOG industry. To make these contributions, I conducted extensive field research in the Bakken, a shale formation covering eastern Montana and western North Dakota.

Unconventional Oil and Gas Development and the Bakken

In the early 2000s, high oil prices, the technological innovations of hydraulic fracturing and horizontal drilling, and other political and economic factors coalesced to create a boom in unconventional oil and gas development. Shale formations that were previously dismissed as economically unviable became both accessible and profitable (Fleming et al. 2015; Wang and Krupnick 2013). This led to an upswing in UOG development, the so-called “Shale Revolution,” which occurred more rapidly and was more geographically dispersed than previous energy booms (Fleming et al. 2015; Measham, Fleming, and Schandl 2016). In 2019, crude oil from tight oil resources accounted for 63% of the total oil production in the United States (US Energy

Information Administration 2020b). More broadly, the rapid increase in oil and gas output led to significant economic and geopolitical shifts in global commodities markets (McNally 2017; O’Sullivan 2017).

The Bakken Formation

The Bakken Formation is a rock unit within Williston Basin, which extends between the Canadian provinces of Saskatchewan and Manitoba, as well as Montana, North Dakota, and South Dakota in the United States. While UOG production targeting the Bakken Formation has occurred in the Canadian provinces, production is far more prolific in the United States due to differences in geology and the regulatory environment. As depicted in Figure 1.1., the American side of the Bakken is an extensive oil play covering 20 counties in eastern Montana and western North Dakota. From a geologic perspective, the Bakken formation refers to horizontal bands of sediment deposits from the Devonian and Mississippian periods located roughly two miles below the surface (Gaswirth et al. 2013). Given the formation’s low permeability, it is considered a light tight oil play (Maugeri 2013). The rock unit’s natural vertical fractures – indicative of potential oil – make this deposit well suited to hydraulic fracturing and horizontal drilling (Pitman, Price, and LeFever 2001). These technologies enabled the extensive and rapid development that characterized the shale revolution of the early 2000s.

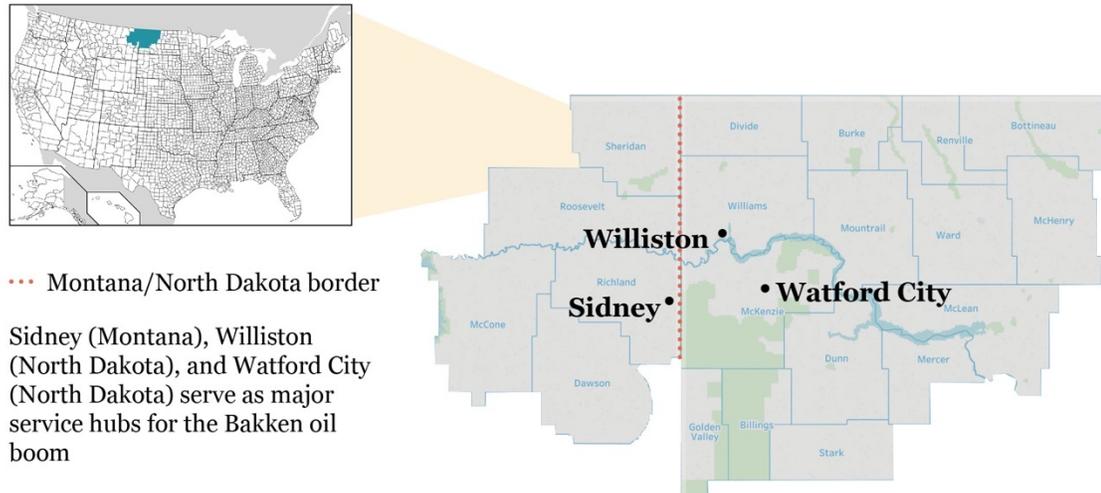


Figure 1.1. The geography of the Bakken in eastern Montana and western North Dakota.

The Bakken's history of oil production illustrates its complex interconnections with global markets, multinational energy companies, and volatile economies. Oil exploration in the Bakken region began in the late 19th century with episodic exploration and production continuing to the present day. The British Amerada Oil Company (now known as Hess) drilled the first commercially viable well in 1951 in Williams County, North Dakota (Hennip 1973; Herz 2013). Several months later, oil development also began on the Montana side of the basin. In the mid-1970s, in response to increased oil prices from global geopolitics, energy companies returned to the Williston Basin, prompting the area's first major oil boom (Hennip 1973). While this boom lasted for several years, by 1982 drilling had slowed down, causing unemployment rates to skyrocket and outmigration in both North Dakota and Montana. Oil production lagged for the next twenty years, until the high oil prices of the 2000s coupled with increased efficiencies in technology prompted another boom – the Shale Revolution (Maugeri

2013). The pace and scale of UOG development far exceeded the region's previous booms, but community members' prior experiences with the oil industry have and continue to shape their experiences with UOG.

The Bakken is a dramatic example of how UOG development can transform rural geographies. Between 2005 and 2014, total oil production in North Dakota increased from less than 100,000 barrels of per day to over 1,000,000 barrels (McNally and Brandt 2015). Given the region's remote economic geography and the scale of production, a large workforce had to be recruited to the area. The rapid population growth coupled with extensive industrial production created new demands for infrastructure, including housing, utilities, and roads. Some of the major service hubs, including Williston and Watford City, more than tripled in population size. Not surprisingly, many communities in the Bakken were overwhelmed by the UOG development and its demands on their services and infrastructure. The region transformed from being isolated and slightly depopulating to an "extractive resource urban rurality" marked by rapid growth and increasing dependence on oil prices (Gilbertz, Anderson, and Adkins 2020). Despite the region's dramatic experiences with UOG development, this geography has received significantly less research attention due to its geographic remoteness (Walsh and Haggerty 2019).

My dissertation aims to broaden the literature on the Bakken. It investigates three overarching questions related to UOG impacts. First, what are the governance processes and public investments at the local level that enable UOG development? Second, to what extent are local communities within the Bakken able to leverage UOG development into

long-term benefits, avoiding the risks of dependence? And, third, in a practical sense, how can rural resource peripheries improve their experiences with UOG?

Methods

I used a mixed method, predominantly qualitative approach to operationalize my dissertation's research questions. I collected data between 2016 and 2020. My research had extensive field research components. Over the course of five years, I spent 156 days living and researching in eastern Montana and western North Dakota. My research included short weekend trips and longer stays, including a 53-day trip in the summer of 2017 and a 43-day trip in the summer of 2018. My research methods included interviews, participant observations at public events and meetings, a survey of township officials, and extensive document analyses of state government testimonies (over 6,000 pages), board meeting minutes, county and city plans and associated documents, newspaper articles, and socioeconomic data. The specific data used for each research article are covered in more detail in each chapter of this dissertation.

My field research in the Bakken began as a research assistant for Dr. Julia Haggerty on her USDA NIFA project (#2014-05498), "Escaping the Resource Curse: Leveraging the Benefits of Energy Development for Rural Prosperity." This grant introduced me to Communities in Action, a group with whom I maintained a relationship throughout my doctoral studies (though the grant ended in 2018). Communities in Action is a bridging organization in Richland County, Montana, that coordinates the county's community initiatives and groups with the goal of improving quality of life. In 2016 our research team facilitated a series of townhall meetings for Communities in Action: two in

Sidney (a public meeting and a meeting at Sidney High School), two in Fairview (a public meeting and a meeting at Fairview High School), one in Lambert, and one in Savage. In 2017 I helped MSU Extension staff facilitate a subsequent townhall meeting focused on crafting a strategic plan and streamlining the organization's mission. Several articles and reports from this collaboration are published outside of this dissertation (e.g., Haggerty et al. 2018; Mastel et al. 2016). On my own time, I facilitated focus groups for the organization and conducted a program evaluation of their AmeriCorps program. My ongoing collaboration with Communities in Action was critical in helping me understand the region's culture and deepening my relationships with community members in eastern Montana.

In 2018, I was awarded an USDA NIFA Predoctoral Fellowship (Project #2017-07020). This grant enabled me to spend significantly more time in the Bakken. My research focus shifted from Communities in Action in eastern Montana to the impacts of UOG development in western North Dakota. While in the field, I typically stayed in either Williston or Watford City, North Dakota. I kept extensive field notes during my research trips and took many pictures to help capture everyday life in the Bakken. I included a selection of these pictures in chapter three of this dissertation with the goal of providing a more comprehensive view of this region than is typically represented in the media's portrayal of the Bakken. The opportunity to live in the Bakken for more than five months opened my eyes to the beauty of the landscape, the region's challenges and opportunities, and the deep commitment that western North Dakotans have to their communities.

In total, I conducted 93 interviews in the Bakken with a range of local and state stakeholders, from landowners to elected officials to government employees. I conducted both in-person and telephone interviews using a semi-structured format, which provided me the “freedom to digress” to explore emergent themes as needed (Berg and Lune 2004, 61). I identified research participants by creating lists of local and state decision makers and by snowballing through research participants. I recorded most interviews (a total of 88 hours) and had them transcribed verbatim for analysis. When interviews were not recorded, I took notes and wrote reflections after the interview.

In addition to interviews, I conducted participant observations and attended many meetings and conferences on topics relevant to my research. These meetings ranged from local to regional, state, and national in scope. This is a small sample of the types of meetings I attended: Northwest Landowners Association annual meetings, a Richland County Conservation District meeting, North Dakota State Water Commission meetings, a Western Dakota Energy Association annual meeting, an EmPower ND Energy Conference, the Ports to Plains Alliance Annual Conference, and the National Transportation in Indian Country Conference. I also attended countless meetings and community events in Watford City and Williston. When relevant, I recorded parts of public meetings and had them transcribed for analysis. Additionally, community members at times invited me to their homes and gave me tours of their farms, ranches, and towns. In 2018 I was given a personal tour of the largest oil spill in western North Dakota by the landowner. When I was not able to record these types of interactions, I

wrote extensive notes and reflections. North Dakotans showed me an immense amount of hospitality throughout my doctoral studies and to them I am forever grateful.

My research process was iterative, exemplifying what Berg and Lune (2004, 25) dub a “spiraling research approach” that moved forward and backward between literature review, data collection, analysis, and dissemination. Throughout the research process, I used constant comparative analysis and Ellington’s theory of crystallization as guiding frameworks. Constant comparative analysis creates rigor as researchers (re)read and analyze data, code and categorize themes, and compare/contrast themes to subsequent readings of data and literature (Corbin and Strauss 2008). Lindlof (1995) further describes this strategy as a cyclical and continuous process of reducing, expanding, explaining, and theory building. Similarly, the goal of crystallization is to seek and define multiples ways of understanding a problem (Ellingson 2009). Crystallization argues for a pluralistic approach to creating rigor in qualitative research by rejecting simple dichotomies in favor of identifying multiple perspectives. Both constant comparative analysis and crystallization attempt to embed order within the chaotic world of qualitative research.

At the practical level of making sense of my data, I uploaded transcribed interviews, documents, and field notes to Nvivo, a code-and-retrieve software. Data were coded, and codes were continually collapsed, expanded, and/or recoded through multiple readings. Emerging themes were compared and contrasted with previous findings from the literature. Throughout my doctoral studies, the data collection, analysis, and writing phases were often overlapping. My approach resulted in an enormous amount of data and

personal experiences, which at times felt overwhelming. However, this approach helped me fulfill Golden-Biddle and Locke's (1993) three dimensions of successful qualitative research: authenticity, plausibility, and criticality. My on-the-ground experiences coupled with interviews, my work with Communities in Action, the township survey, and extensive document analyses ensured that I understood impacts from UOG development from multiple perspectives.

Dissertation Overview

The goal of this dissertation is to investigate how UOG impacted communities in the Bakken, how community members and governments responded, and what the implications are for communities in the long term. Chapter two offers a comprehensive overview of the literatures which this research draws upon, including economic geography, community resilience studies, the energy impacts literature, and infrastructure studies. Subsequent research chapters draw upon this foundational chapter, and the reader should expect some redundancy. In chapter three I present a series of my photographs that I took over the five years of my field research to help provide a more nuanced overview of the Bakken region. This chapter is designed to illustrate how the Bakken is a more complex geography than is typically represented in the media and or in the popular imaginary of boomtowns.

Chapters four, five, six, and seven are a collection of research manuscripts that have either been published in peer-reviewed journals (chapters four, five, and six) or are being prepared for submission to a peer-reviewed journal (chapter seven). Chapter four is

the first of the research articles. This chapter focuses on a case study of the Northwest Landowner Association, a lobbying organization of farmers and ranchers in North Dakota that has helped make improvements to pipeline reclamation processes. Chapter five is a case study of the use of shared services in the Bakken, which is shown to be simultaneously innovative but also carries the risk of entrenching dependence. Chapter six is a detailed investigation into the Western Area Water Supply project, a regional water infrastructure project that was financed as a public private partnership with industry. This chapter highlights the messiness of how resource dependence occurs in practice. Chapter seven focuses on how the UOG development impacted road infrastructure throughout the region and the extent to which local and state governments accommodate and enable industry. In the conclusion, chapter eight, I make the argument that regions with UOG development are a distinct geography of production and a distinct geography of public finance.

References Cited in Chapter One

- Berg, B. L., and H. Lune. 2004. *Qualitative research methods for the social sciences*. Upper Saddle River, NJ: Pearson Education.
- Corbin, J., and A. Strauss. 2008. *Qualitative research*. Thousand Oaks, CA: Sage.
- Ellingson, L. L. 2009. *Engaging crystallization in qualitative research: an introduction*. Thousand Oaks, CA: Sage.
- Fleming, D., T. Komarek, M. Partridge, and T. Measham. 2015. The booming socioeconomic impacts of shale: a review of findings and methods in the empirical literature. Munich Personal RePEc Archive, 68487, Munich, Germany.
- Gaswirth, S. B., K. R. Marra, T. A. Cook, R. R. Charpentier, D. L. Gautier, D. K. Higley, T. R. Klett, M. D. Lewan, P. G. Lillis, C. J. Schenk, et al. 2013. Assessment of undiscovered oil resources in the Bakken and Three Forks Formations, Williston Basin Province, Montana, North Dakota, and South Dakota, 2013. US Geological Survey Fact Sheet, 3013, Department of the Interior, Washington, DC.
- Gilbertz, S. J., M. B. Anderson, and J. M. Adkins. 2020. The Bakken blind field: investigating planetary urbanization and opaqueness in the oil and gas fields of eastern Montana. *Annals of the American Association of Geographers*: 1–18.
- Golden-Biddle, K., and K. Locke. 1993. Appealing work: an investigation of how ethnographic texts convince. *Organization Science* 4 (4): 595–616.
- Haggerty, J. H., K. K. Smith, T. Mastel, J. Lapan, and P. Lachapelle. 2018. Assessing, monitoring, and addressing boomtown impacts in the US: evaluating an existing public health model. *Impact Assessment and Project Appraisal* 36 (1): 115–27.
- Hennip, R. D. 1973. History of the crude oil industry in Montana. MBA thesis, University of Montana.
- Herz, C. A. 2013. Petroleum exploration history in North Dakota to 1951. M. thesis, University of North Dakota.
- Lindlof, T. R. 1995. *Qualitative communication research methods*. Vol. 3. Thousand Oaks, CA: Sage.
- Mastel, T., K. K. Smith, J. H. Haggerty, and K. B. Walsh. 2016. Communities in Action program evaluation: report to Richland County Department of Public Health. Resources and Communities Research Group, Department of Earth Sciences, Montana State University, Bozeman, MT.

- Maugeri, L. 2013. The shale oil boom: a US phenomenon. Harvard Kennedy School, Belfer Center for Science and International Affairs, Cambridge, MA.
- McNally, R. 2017. *Crude volatility: the history and the future of boom-bust oil prices*. New York: Columbia University Press.
- McNally, M. S., and A. R. Brandt. 2015. The productivity and potential future recovery of the Bakken formation of North Dakota. *Journal of Unconventional Oil and Gas Resources* 11: 11–8.
- Measham, T. G., D. A. Fleming, and H. Schandl. 2016. A conceptual model of the socioeconomic impacts of unconventional fossil fuel extraction. *Global Environmental Change* 36: 101–10.
- O’Sullivan, M. L. 2017. *Windfall: how the new energy abundance upends global politics and strengthens America’s power*. New York: Simon and Schuster.
- Pitman, J. K., L. C. Price, and J. A. LeFever. 1999. Diagenesis and fracture development in the Bakken Formation, Williston Basin. Implications for reservoir quality in the middle member: United States Geological Survey Professional Paper 1653, U.S. Geological Survey, Denver, CO.
- US Energy Information Administration. 2020a. Drilling productivity report, October 13, 2020. <https://www.eia.gov/petroleum/drilling/>.
- US Energy Information Administration. 2020b. Frequently asked questions: how much shale (tight) oil produced in the United States? <https://www.eia.gov/tools/faqs/faq.php?id=847&t=6>.
- Walsh, K. B., and J. H. Haggerty. 2019. I’d do it again in a heartbeat: coalbed methane development and satisfied surface owners in Sheridan County, Wyoming. *The Extractive Industries and Society* 6 (1): 85–93.
- Wang, Z., and A. Krupnick. 2013. US shale gas development: what led to the boom. *Resources for the Future*, 13 (4): 1–14.

CHAPTER TWO

LITERATURE REVIEW

This review of the literature outlines the major arguments that my dissertation is responding and contributing to within the fields of economic geography, community development and resilience studies, energy impact studies, and infrastructure studies.

Economic Geography & Resource Peripheries

Economic geographers define resource peripheries as sites of natural resource extraction that enable global processes of capital accumulation (Hayter, Barnes, and Bradshaw 2003; Wallerstein 2004). These rural and remote geographies typically subsume the costs of resource extraction while the benefits are exported elsewhere, along with the resource. The usefulness of specific resource peripheries to capitalism constantly shifts as particular resources and geographies move in and out of favor as spatial fixes (Harvey 2001, 2005). On the ground, this dynamism is often experienced as crises of disinvestment and accumulation by dispossession. Hayter, Barnes, and Bradshaw (2003, 19) argue that “booms, busts, dependence, exploitation and vulnerability are recurrent themes of resource peripheries.” Thus, resource peripheries offer important insights into the inherent volatility and unevenness of globalization (Halseth 2016; Harvey 2001).

Economic Dependence

The risk of economic dependence is a key concern for resource peripheries. There are various approaches to defining and conceptualizing resource dependence and its

outcomes (Barnes et al. 2001). Econometric approaches aim to model universal concepts through statistical analyses, often seeking statistical evidence of economic dependence and the drivers of its negative outcomes (e.g., crowding out effects, industry structure or ownership, poverty, market structure and volatility). This approach is prevalent within the resource curse literature (e.g., Ross 1999; Sachs and Warner 2001). Further, these approaches can integrate social and development metrics, such as by analyzing the relationship between dependence and metrics of community wellbeing (e.g., Stedman et al. 2004; Tonts et al. 2012). More qualitative “local model” approaches to resource dependence foreground geographic context and the “messiness, contingency, and disorder” that universalizing approaches tend to ignore (Barnes and Hayter 2005, 454). Staples theory and critical political economy frameworks operate within this vein of research and investigate how development trajectories are shaped by political, economic, and social histories (e.g., Argent 2016; Halseth and Ryser 2017; Walker 2001; Watts 2004).

A prominent line of inquiry in the economic geography literature examines the structural constraints that heighten resource peripheries’ risk of dependence and restrict their options to diversify their economy (Freudenburg 1992; Halseth and Ryder 2017). Resource extraction in peripheries tends to be capital intensive, creating power imbalances between communities and the large, multi- or trans-national companies that they host. These factors often give rise – whether intentionally or not – to distinct production complexes in which private and public sectors align to foster a pro-industry, pro-extraction political economy (Freudenburg 1992). As a result, communities run the

risk of becoming over-adapted to industry's needs, even when community leaders are actively working to diversify their economy and avoid dependence. Factors that can limit peripheries' range of opportunities include high sunk costs into industrial development and infrastructure, the community's alignment with industry, low capacities and/or access to resources, amongst others (ibid.). When industry leaves, the legacies of prior investments remain, constraining and/or enabling new rounds of investment (Halseth 2016). The uncertainties surrounding the long-term impacts of resource extraction in peripheries are a defining feature of these landscapes, one that complicates local and regional planning processes, economic diversification strategies, and cost-benefit assessments.

The structural challenges of resource peripheries compound broader challenges to rural geographies stemming from rural restructuring and the impacts of neoliberal policies. Over the last century, rural communities have experienced dramatic changes in economic structures, governance, and demographics (Woods 2005). Many rural areas that historically relied on primary production (agriculture, timber, mining, etc.) have experienced massive layoffs, declining wages, and increasing poverty related to changing economic conditions nationally and globally (Hibbard and Lurie 2015). Under the neoliberal regime, governance is increasingly being devolved from federal levels to localities, regardless of whether local communities have the capacity to take on these added governance burdens (Halseth 2016). Economic restructuring due to deregulation and governance devolution have led to a loss of service provision with significant impacts to quality of life and community capacity in rural geographies (Halseth and

Ryser 2006; Woods and Goodwin 2003). Consequently, resource peripheries may feel trapped by contradiction: either they continue to invest in resource extraction and risk dependence or they attempt to diversify their economy only to find their options have been constrained by political and economic shifts outside their control.

Yet, resource peripheries are more complex than mere examples of resource dependence and uneven development. Despite being deeply integrated into the global economy, they are not powerless (Barnes and Christophers 2018). These diverse geographies are contested spaces, shaped by a mix of endogenous and exogenous forces (Hayter, Barnes, and Bradshaw 2003; Wilson 2012). Rural resource communities are often innovative in the face of disruption (Smith et al. 2018; Smith and Haggerty 2020;), though their ability to overcome economic challenges and leverage resource development into long-term prosperity is constrained. This raises questions about how to understand resource dependence: a tension exists between the structural constraints that characterize peripheries and their ability to foster resilience and direct their own future (Coe, Kelly, and Yeung 2020). The community development and resilience literatures offer more robust frameworks for understanding the agency of local places than are typically found in the economic geography literature.

Community Development and Community Resilience

Given the structural challenges imposed on local places, community and economic development practitioners have turned towards community resilience as a framework for building capacity at the local level. However, resilience is a slippery concept. While its historical roots are in ecology and community psychology, multiple

disciplines with differing ontologies and epistemologies have adopted the word “resilience” for their own purposes, creating a risk that resilience will become so unbounded as to mean nothing at all. Table 2.1 offers an example of the different definitions assigned to resilience. Further complicating the idea, many community organizations and grassroots activists employ resilience “as a concept for designing community-driven approaches to environmental and social issues,” repurposing the term to achieve their own normative goals (Cretney 2014, 634). This stands in stark contrast to the objective social-ecological definition, in which resilience can refer to either desired or undesired states (Walker and Salt 2012). Despite these varying definitions and uses, researchers have argued that resilience’s focus on flexibility and acceptance of uncertainty, adaptive capacity, and transformation provides useful guidance for a world that is increasingly complex and unpredictable (Walsh-Dilley, Wolford, and McCarthy 2016). In this section I will briefly outline the roots of social-ecological resilience and community resilience with the goal of demonstrating their use for applying to resource peripheries.

Table 2.1 Differing definitions of resilience from the literature.

Resilience Definition	Type	Text / Authors	Year
“Resilience determines the persistence of relationships within a system and is a measure of these systems to absorb changes of state variables, driving variables, and parameters, and still persist.”	Social-ecological resilience	“Resilience and Stability of Ecological Systems” C.S. Holling	1973
“Resilience is the magnitude of disturbance that can be tolerated before a socioecological system moves to a different region of state space controlled by a different set of processes.”	Social-ecological resilience	“From Metaphor to Measurement: Resilience of What to What?” S. Carpenter, B. Walker, J. M. Anderies, N. Abel	2001
“Resilience is the capacity of a system to absorb the disturbance and still retain its basic function and structure.”	Social-ecological resilience	<i>Resilience Thinking: Sustaining Ecosystems and People in a Changing World</i> ; B. Walker, D. Salt	2006
“...a process linking a set of adaptive capacities to a positive trajectory of functioning and adaptation after a disturbance.”	Community resilience	“Community Resilience as a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness” F.H. Norris, S.P. Stevens, B. Pfefferbaum, K.F. Wyche, R.L. Pfefferbaum	2008
“...the existence, development, and engagement of community resources by community members to thrive in an environment characterized by change, uncertainty, unpredictability, and surprise.”	Community resilience	“Community Resilience: An Indicator of Social Sustainability” K. Magis	2010

Social-ecological Resilience

In the 1970s, Holling (1973) proposed resilience as a reaction against the dominant resource management strategies of the time, many of which operated from assumptions that ecological change was linear and predictable and thus could be managed

to achieve equilibrium. This static form of management attempted to maximize yields, efficiency, and/or economic profits in way that prioritized specific goals without regard to broader and longer-term changes to the ecosystem (Folke 2006; Walker and Salt 2006). In contrast to static management regimes, Holling (1973) described ecosystems as constantly evolving systems that should be managed to promote an ecosystem's perseverance given the assumption that unpredictable shocks and stressors will occur. A resilient system, he posed, was a system that could absorb changes and persist.

Building upon Holling's breakthrough, resilience was adopted into social-ecological systems as an interdisciplinary framework that acknowledged the interdependence and coevolution of ecological and social systems (Folke 2006). Walker and Scott (2006, 1) defined social-ecological resilience as "the capacity of a system to absorb disturbance and still retain its basic function and structure." A resilience perspective emphasizes the uncertainty within social-ecological systems and the need for adaptive management to stay within critical thresholds (Folke 2006). Holling's (1986) adaptive cycle, as shown in Figure 2.1., illustrates how ecological systems are constantly in flux. While systems are in the exploitation phase I, they consolidate resources and begin to specialize functions, moving them into the conservation (K) phase. As specialization is increasingly ingrained, the system becomes more inflexible and brittle, leading to the crisis or release phase (Ω) in which the system collapses. During the chaotic reorganization phase (α), new forms of organization are possible, marking a period of potential creativity and innovation (Folke 2006). Once they are established, they begin to be exploited. The cycle continues with periods of rapid and gradual change.

Gunderson and Holling (2002) introduced the concept of panarchy to illustrate the interdependencies and cross-scale interactions between hierarchies of adaptive cycles.

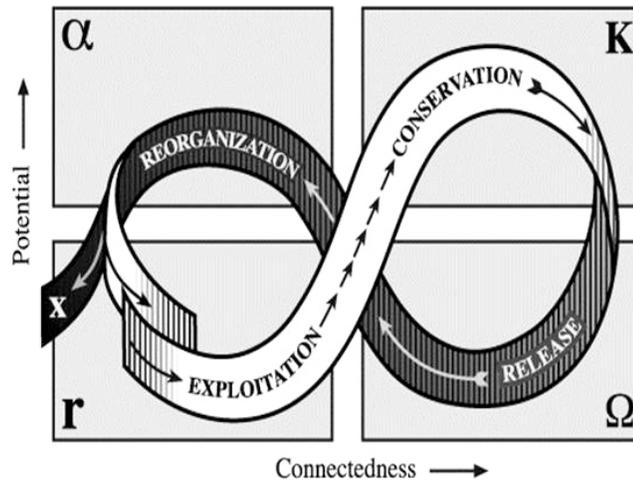


Figure 2.1. The four phases of the adaptive cycle in the resilience framework.

Source: Holling, C. S., and L. Gunderson. 2002. *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington, DC: Island Press.

The adaptive cycle as it relates to resilience is illustrated in many social-ecological system case studies. For example, in the Goulburn–Broken Catchment of northern Victoria, resource managers attempted to control flooding by building levees (Walker and Salt 2006). However, the levees led to unforeseen consequences, such as requiring heavy maintenance, frequent failures (approximately once every ten years), and contributing to more extreme flooding downstream. The levees represented a solution that managed for one specific goal (water control) but exacerbated other ecological problems and produced rigidity within the system, compromising its resilience. Further, once the levees were built, they became embedded within multi-scalar social systems, including private property, weather patterns, and politics. These social systems impacted

the levees' level of social acceptance and the range of alternative management solutions when the levees were not effective. Within this panarchy, the levees can be understood as a short-term techno-fix that failed to incorporate the need for adaptive management in a constantly evolving social-ecological system. In social-ecological systems physical infrastructures are often blamed for creating "locked-in" effects, furthering specialization in the conservation phase, and decreasing resilience (Adger 2000; Walker and Salt 2006). Infrastructure that is built for control is frequently a symbol of rigidity within an adaptive cycle, creating a brittle system that requires maintenance and increases environmental harms (Smith and Stirling 2010).

Within the adaptive cycle, crisis and release create opportunities for change. Whether related to the social, economic, and/or ecological systems, the release phase marks "renewal of the system and emergence of new trajectories" (Folke 2006, 259). Innovations during this period, however, can be limited by structures within the system, such as the poverty trap (due to lost capital during release phase), the hierarchy trap (isolation limits experimentation), and/or the lock-in trap (existing capitals' sunk costs are too high) (Holling and Sundstrom 2015). Social-ecological resilience identifies the need to understand thresholds and feedback loops, while promoting flexibility, biodiversity, social capital, innovation, and redundancy (Walker and Salt 2006). Similarly, adaptive governance emphasizes the need to plan for change and to create opportunities for ecological learning, public participation, experimentation, and flexibility (Walker and Salt 2006; Wilkinson 2011).

Methodologically, social-ecological resilience studies frequently rely on system analysis and modeling. Modeling allows researchers to explore different hypothetical management scenarios and provide insights into how ecosystem dynamics interact in complex and unexpected ways (Holling and Sundstrom 2015). Increasingly, researchers working in communities employ participatory modeling, scenario planning, and impact assessments to aid discussions and collaborative decision making with communities. For example, in New York's Adirondack Park, Erickson and O'Hara (2000) employed a participatory impact assessment to guide resource discussions that prioritized community wellbeing, economic development, and sustainable timber management. Modeling is a useful tool for resilience planning, but it can also be misused. Like any model, the scenarios developed are highly dependent on the data available and can be sensitive to small changes (Parrott et al. 2012). When researchers present the model as offering definite answers to management questions, as opposed to a tool for fostering discussion, the model's effectiveness is diminished.

Community Resilience

Drawing on insights from SES resilience, community resilience scholars understand communities as complex, constantly evolving systems with differing capacities and vulnerabilities (Adger 2000; Magis 2010). Community resilience is the ability of a community to leverage its assets and resources to meet challenges presented by an uncertain and unpredictable future (Magis 2010; Wilkinson 2011). Folke (2016, 1) describes resilience as encompassing "persistence, adaptability, and transformability," further emphasizing the need for communities to be nimble and proactive. Definitions of

community resilience tend to have a more normative stance than social-ecological resilience definitions. In this context, communities *should* strive for resilience. However, many researchers urge community resilience practitioners to treat resilience as a dynamic process as opposed to an outcome or desired stability (Norris et al. 2008).

Researchers have attempted to understand what characteristics, capacities, and/or infrastructures make some communities more resilient or vulnerable than others. The existing literature suggests that key features of community resilience include strong social capital with linkages between disparate stakeholders and organizations (Besser 2013; Harrison, Montgomery, and Bliss 2016), economic diversity (Adger 2000; Martin and Sunley 2014), and the ability of the community to learn, self-organize, and problem solve (Berkes and Ross 2013). Given resilience's assumption that communities and social-ecological systems are complex, no single stakeholder or organization is seen as having complete knowledge (Robinson and Berkes 2011). Collaboration and partnerships are essential. Communities are thus seen as greater than the sum of their parts, "meaning that a collection of resilient individuals does not guarantee a resilient community" (Norris et al. 2008, 128). Other important attributes of resilience include having inclusive and collective governance systems (Berkes and Ross 2013; Kulig et al. 2013; Norris et al. 2008) and strong institutions that are willing to partner and experiment (Anderies, Janssen, and Ostrom 2004).

Carpenter and colleagues (2001) stress that researchers must identify resilience *of what* and *to what* in their research. Often community resilience is defined as the resilience of a community (its existence or its wellbeing) in relation to a disaster, hazard,

and/or economic shock. Besser (2008) categorizes shocks as either corrosive or consensus building. Corrosive shocks tend to exacerbate differences or inequalities within the community and/or highlight differences that were previously hidden. These shocks heighten tensions with the community and often stem from disruptions that are longer term or could have been predicted, for instance a factory going out of business. Consensus building shocks are unpredictable events, such as a tornado or earthquake, that prompt residents to rally together to meet unexpected challenges. Shocks, however, are frequently a combination of corrosive and consensus building factors and can behave in unexpected ways. For example, Norris (2008) described Hurricane Katrina in New Orleans as a shock that could have been consensus building because of its unexpectedness but instead resulted in a highly corrosive shock that underscored the enormous environmental injustices embedded in the city's settlement patterns.

Community resilience methodology typically differs from social-ecological resilience. While social-ecological resilience studies tend to employ modeling techniques, community resilience studies frequently use resilience and/or vulnerability assessments. These employ qualitative and quantitative data collections to assemble socioeconomic indicators that speak to one's perceived resilience, vulnerability, and/or quality of life. Several assessments have been developed to standardize data collection. For example, the community capitals framework measures a community's resources and capacities in seven sectors: natural, cultural, human, social, political, financial, and built capitals (Emery and Flora 2006). Other researchers advocate for individualized assessments that speak more directly to a community's needs. Ross and Berkes (2014) call for more

participatory research that contributes to research participants' understandings of community resilience, strengthens their community's resilience through the research process, and includes continual monitoring. Through the process of researching their own resilience, the rationale goes, communities will be more likely to see opportunities for transformation.

Political Ecology and Resilience Studies

Political ecologists have increasingly engaged, both as critics and supporters, with resilience studies. Political ecologists seek to combine analyses of ecology with the political economy, frequently illustrating how local ecological impacts can be seen as symptoms of larger regional, national, and global political and economic forces (Blaikie 1985; McCarthy 2002; Robbins 2012b). Similar to the breadth of resilience definitions and approaches, political ecology also encompasses a spanning body of literature. This diversity prompted Robbins (2012b) to describe political ecology as better understood as a community of practice as opposed to a more delineated academic discipline.

Several researchers have noted that political ecology and resilience matured during the same time period – roughly the 1970s and 1980s – as reactions against static, equilibrium models of ecosystem and resource management strategies that sought to maximize short-term yields or efficiency (Peterson 2000; Turner 2014). This suggests commonalities that could be used to unite the two bodies of literature. Others, however, have argued that resilience studies underestimate the importance of the political economy and/or lack the critical edge that political ecologists seek to bring to their work, limiting their compatibility (Huber 2015; Nelson 2014). Wilkinson (2011, 149) argued that

resilience has “yet to develop a strong theoretical basis for addressing matters of power, conflict, contraction, and culture.” This section will provide a brief overview of political ecology’s origins and how political ecology can be used to strengthen the resilience framework.

Given the present diversity of political ecology, its roots are equally diverse, ranging from environmental history to cultural ecology, hazards studies, ecological economics, environmental anthropology, and beyond (Bridge, McCarthy, and Perreault 2015). Many early political ecology researchers were interested in the interconnections between humans and environments, land management, the importance of localized knowledge, and how people make natural resource decisions (Robbins 2012b). In its early years, researchers focused on economies transitioning from subsistence to market economies and how processes of commodification disrupted ecologies and local livelihoods. These studies often critiqued development studies and top-down command and control resource management strategies led by the state. For example, Piers Blaikie (1985), in *The Political Economy of Soil Erosion in Developing Countries*, refocused the problem of soil erosion from being a technical land management issue to a more complex set of relationships between local land users, conflicted scientific understandings of erosion, market forces, and colonial and post-colonial political interventions. Throughout the early era of political ecology, political ecologists primarily employed qualitative field work and ethnography to write case studies about communities that were shown to be increasingly connected to globalization and capitalism, pointing out many of the local struggles that arose from these deepening relationships.

In the late 1990s and early 2000s, political ecologists began turning their attention toward first-world political ecology. McCarthy (2002) was an early leader in this shift with his critique of the Wise Use movement in the American West. By juxtaposing Western rural landowners who identified with the Wise Use movement with research subjects from past political ecology studies, he questioned why audiences in the United States were sympathetic of the plight of rural locals in the developing world but critical of the same agriculture stakeholders in their backyards. A growing body of literature, including St. Martin (2001), Walker (2003), and Robbins (2012a), argued that political ecology has useful insights for so-called first world settings. Although the definition of the state is different in these contexts, the authors noted that many of the same tensions and conflicts that traditional political ecology focused on – disagreements between local and “official” knowledge and local control of resources versus top-down control (Robertson 2015) – could be seen in places like the United States. Given the increasing dominance of resilience approaches to rural development, political ecology is well poised to offer critiques and improvements to resilience studies.

Using the resilience framework and taking into account political ecology’s critiques, an energy boom can be considered an economic shock. This fits within Besser, Recker, and Agnitsch’s (2008, 581) definition of economic shocks as “sudden events that have had significant impacts on local economies.” Researchers have noted that economic diversity can contribute to resilience and that resource-dependent communities, such as energy boomtowns, are particularly vulnerable for their overreliance on a single economic sector (Adger 2000). If energy booms are understood as a shock or a crisis,

then there exists the possibility that communities could leverage the shock for positive and desired transformation. However, to date, little research has investigated how energy enhances or detracts from community and economic resilience in resource peripheries. More research is needed to understand how communities could leverage an energy boom into transformation.

Energy Impacts: Unconventional Oil and Gas

Beginning in the 1970s, in response to booms in coal and oil production, interest in studying the social impacts of industrial energy developments soared (Smith, Krannich, and Hunter 2001). The social disruption model (also called the boomtown model) emerged as a dominant paradigm for analyzing the community impacts of energy projects. This research focused on the “mix of positive and negative economic impacts to local residents, contrasted with highly negative social impacts” (Jacquet 2009, 8). Notably, the social problems associated with energy development received the majority of attention in the early phases of this literature. For example, ElDean Kohrs (1974) proposed the Gillette syndrome to describe the variety of social ills – from increases in divorce rates to more criminal activity – that developed from intensive coal mining in Gillette, Wyoming. Similarly, Gilmore (1976) proposed the problem triangle to describe how boom and bust dynamics resulted in degraded QOL, declining industrial productivity, and the failure of local services and infrastructure to meet expanding needs. The social disruption model created a powerful narrative about social problems of booms that continues to shape academic discussions and research about current energy boomtowns.

While the social disruption model is still a powerful narrative, it resulted in a backlash. Critics argued that the model was biased, underestimated economic benefits, and used questionable and unreproducible methods to justify research findings (Jacquet 2009). Researchers noted that one-off studies failed to differentiate between short- and long-term impacts, and called for more longitudinal research to address this gap in the literature (Olien and Olien 1982; Wilkinson 1982). To further complicate the academic literature, many of the negative reactions to the social disruption model were in turn critiqued as being overly influenced by industry and/or built upon unrealistic input/output models (Barth 2013). The resulting hodgepodge of findings from the energy impacts literature of the 1970s and 1980s illustrates the complexity of developing comprehensive assessments of the costs and benefits of industrial energy development.

Unconventional Oil and Gas (UOG) Development

Similar to the energy booms of the 1970s and 1980s, increases in oil and gas production in the 2000s prompted a surge in social science research evaluating the local impacts of energy development. Unconventional oil and gas development (UOG) is a broad term referring to extraction techniques that are employed when the geology of the reservoir prevents oil and gas from readily flowing (U.S. Energy Information Administration). In this dissertation, UOG refers to oil and gas extraction in low-permeable shale formations that are drilled using hydraulic fracturing and horizontal drilling. The “shale revolution,” which began in the early 2000s, refers to the increased use of UOG techniques: high oil prices combined with improvements in hydraulic fracturing and horizontal drilling to create a surge in domestic oil and gas production that

targeted low-permeable shale formations, such as the ones highlighted in Figure 2.2. This rapid increase in oil and gas output has led to significant economic and geopolitical shifts in global commodities markets (McNally 2017; O’Sullivan 2017)

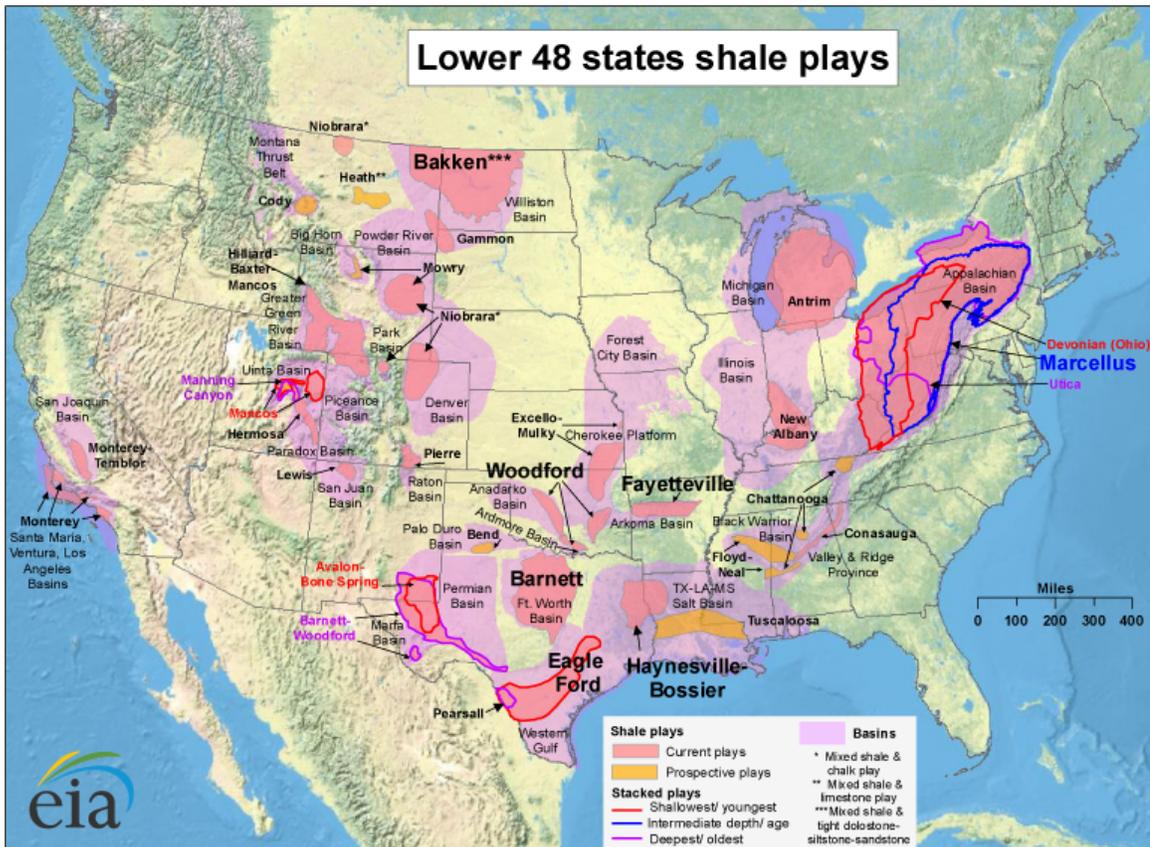


Figure 2.2. The Bakken region in relation to other shale plays in the United States.

Source: U.S. Energy Information Administration. 2011. Review of Emerging Resources: U.S. Shale Gas and Shale Oil Plays. <https://www.eia.gov/analysis/studies/usshalegas/pdf/usshaleplays.pdf>

UOG’s techniques, geography, and impacts are unique from conventional methods. Geographies that previously did not host oil and gas development are now being drilled, increasing national levels of energy sprawl in the U.S. (Trainor 2016). Within regions that host oil and gas, UOG wells are more geographically dispersed and

have more uncertain timeframes when compared to conventional extraction (Jacquet and Kay 2014). Coupled with broader geographic impacts, construction and extraction phases of UOG are marked by an accelerated pace and scale of development (Fleming et al. 2015; Measham, Fleming, and Schandl 2016). This leads to amplified needs related to infrastructure and personnel, particularly during extraction's initial phases, which further increases the footprint of energy development (Allred 2015). Unconventional wells are typically productive over a shorter amount of time, incentivizing development of more wells. While wells can be "re-fracked" to restart production, energy companies continue to spread out in search of new locations. The resulting mini-booms and busts throughout the region reinforce and amplify volatility already present due to commodity markets (Jacquet 2009). Despite the geographic and material differences between unconventional and conventional oil and gas development, the existing regulations and governance mechanisms designed for conventional extraction are largely still used for UOG extraction, though they may be ill-suited for managing landscapes with multifunctional purposes (Measham, Fleming, and Schandl 2016).

UOG development in the US is complicated by its devolved governance and resulting patchwork of state-specific institutions that regulate the industry (Jacquet et al. 2018; Rabe 2014; Ziropiannis et al. 2016). Governance includes the many rules, stakeholders, and institutions – informal and formal – that make allocation decisions regarding natural resources (Bridge and Perreault 2009). In the US, the market primarily controls the pace and scale of UOG development, as opposed to local, state, or federal governments (Witt et al. 2018). Given broader trends that favor devolution of government

responsibilities and deregulation (Harvey 2005; Jessop 2002; Peck and Tickell 2002; Pike, Rodriguez-Pose, and Tomaney 2006), formal UOG regulations and associated fiscal policies are inconsistent and uncoordinated between states. In some states – West Virginia, New Mexico, Colorado, Pennsylvania, Louisiana, and New York – the government has taken a strong lead in developing regulations for UOG (Zirotiannis et al. 2016), while in others the government is slow or reluctant to regulate. The lack of cohesive federal and state planning related to energy development creates a jumble of regulations that vary between states and, at times, can even vary between communities within the same region (Haggerty and Haggerty 2015; Konschnik and Boling 2014).

The devolved governance regulating UOG creates opportunities and challenges for local communities that host development. Industry is not required to conduct formal social impact assessments or monitoring processes when development occurs on private land, leaving companies to selectively choose when and how to self-regulate community impacts, as well as which impacts to address (Haggerty and McBride 2016; Wilson et al. 2017). Landowners can shape how UOG development occurs on their land, but this “private participation” form of planning often does not address regional or cumulative impacts (Jacquet 2015). As public service provision and economic development responsibilities are increasingly devolved (Ryser et al. 2019; Warner 2010), local communities are expected to manage the overwhelming impacts associated with UOG booms while implementing plans for economic diversification – all within a context of limited support, resources, and capacity (Halseth 2016). The results are mixed (e.g., Haggerty et al. 2018; Malin and DeMaster 2016). While the regulatory void surrounding

UOG development creates opportunities for adaptive and creative solutions, the range of local capacities and skillsets available to manage UOG impacts often cannot overcome structural economic vulnerabilities (Silva and Crowe 2015; Smith and Haggerty 2020).

Further complicating the governance of UOG development, the UOG industry is a complex network of operators and subcontractors that work at varying scales, from the international to the very local, with different levels of expertise, organizational cultures, and goals (Small et al. 2014). Stakeholders are continually changing as companies are formed, dissolved, and consolidated, creating practical challenges for communities to form long-term relationships with industry. Jacquet and Kay (2014) note that the increasing role of investment finance in the global energy market adds to the volatility of development at the local scale while subsequently resulting in more complex power dynamics that must be navigated at the local level. Due to the nature of UOG, development responds quickly to global market dynamics while also being highly specific to a complex set of localized variables, ranging from the region's geology to infrastructure needs. UOG development and its local impacts are continually evolving due to the industry's fierce competition. Companies routinely implement new technologies to maximize efficiency and reduce costs, at times addressing community impacts and at other times creating new ones.

For local government officials and planners, the dispersed footprint of UOG and the subsequent uncertainty of development create challenges for successfully mitigating unwanted impacts and capturing potential benefits (Fleming et al. 2015). Christopherson (2012) argues that local governments can generally keep up with services demands when

increases do not exceed 5% growth; however, governance structures and services decline when demands increase by 15% or more. Since UOG is labor intensive and regional in scope, it often results in rapid population growth well beyond a 15% increase. Not surprisingly, given Christopherson's benchmarks, communities that host UOG development often struggle to plan, keep up with service demands, or implement new regulations quickly enough to prevent undesired impacts (Small et al. 2014). Planning at the community level is further exacerbated by the uncertainty of the market and the lack of transparency surrounding the UOG industry (Fleming et al. 2015; Jacquet 2014). UOG companies frequently do not communicate the specific locations or timing of new developments to communities, though their plans will undoubtedly impact government services and infrastructure. Communities are left having to make "best-guess" decisions about how to plan for the future, even though these decisions often have long-term implications that may exceed the life of the UOG industry in their region.

At the local level, it is clear that UOG development creates costs and benefits that are distributed unevenly in communities – demographically, spatially, and temporally (Jacquet, 2014; Rifkin et al. 2015). While communities may benefit from increases in tax revenues, they also must address impacts to their communities, infrastructure, and public services (Fleming et al. 2015; Hitaj et al. 2014; Measham et al. 2016; Newell and Raimi 2018). The ability for communities to absorb and benefit from the boom is dependent on a host of variables, including access to markets and resources, who owns and controls assets, the scope of development, and governance structures (Haggerty et al. 2018). Geographies that are rural and remote are more likely to experience boomtown impacts

from development, including rapid growth, housing shortages, stresses to government services and infrastructure, and a risk for becoming overly dependent on a single commodity (Haggerty et al. 2018; Jacquet 2014). In the short-term, communities are likely to economically benefit from new jobs and increases in tax revenues; however, the long-term economic outcomes of UOG development are still debated within the literature (Raimi 2018). In sum, UOG impacts to rural communities are best understood as tradeoffs, making it difficult for communities to evaluate comprehensive costs and benefits, both in the short- and long-term (Haggerty et al. 2019).

One solution to the challenges that communities experience due to UOG development is to create more coordinated, regional planning and governance processes (Kelsey, Partridge, and White 2014). Regional governance can help address localized impacts by sharing expertise, coordinating infrastructure investments, and creating venues for more proactive planning. As opposed to rural development policies that support reactive, one-time interventions, Morrison (2016) calls for development policies that build adaptive capacity through regional collaboration. These collaborations could potentially be funded with aid from the UOG industry (Measham, Fleming, and Schandl 2016). The existing literature on socioeconomic impacts from UOG clearly shows that energy communities struggle to measure, monitor, and address socioeconomic tradeoffs and frequently lack capacities to fully address undesired impacts. Innovative governance solutions are needed that can take into account the unpredictability of energy markets while remaining proactive.

Infrastructure

Resource and energy geographers are increasingly interested in problems of infrastructure, a trend reflected in a broader “infrastructure turn” in the humanities and social sciences (Howe et al. 2016). Infrastructures are frequently assumed to be objective, permanent, and stable but in practice are inherently political, contingent, and demanding of constant maintenance (Carse 2014; Carse and Lewis 2017; Howe et al. 2016). Notably, infrastructures’ costs are often justified with promises of economic development and increased wellbeing (Kaika 2005; Meehan 2014) but can create unintended risks and/or undesired change (Appel et al. 2018; Harvey and Knox 2015). Researching infrastructure draws attention to processes that are “characterized both by path dependencies and by rupture” as Haarstad and Wanvik (2016) point out in their conceptualization of “carboscapes.” Infrastructure is thus paradoxical: simultaneously creating regeneration and degeneration, connections and disconnections, solving problems while simultaneously revealing new ones (Carse 2014; Howe et al. 2016). The foregrounding of infrastructure’s instabilities and incoherencies highlights their opportunity costs, as well as opportunities for transformation.

Infrastructure has become an increasingly popular subject of study in the social sciences, including the fields of political ecology, industrial ecology, and anthropology (Howe et al. 2016). However, the long-term impacts of infrastructure and its funding mechanisms are largely overlooked and undertheorized within the boomtown, resource dependence, and energy impacts scholarship. This dissertation draws upon the diverse field of infrastructure studies to fill this gap.

One of the confounding aspects of the infrastructure literature is the lack of agreement on the definition of infrastructure, leading to a significant amount of theorizing within the literature (Carse 2017; Howe et al. 2016). Older definitions emphasize the “infra” in infrastructure, implying an emphasis on that which is under or within our built environment. More recent definitions draw heavily on science and technology studies (STS)’s definition and frame infrastructures as relational, networked sociotechnical systems that are interconnected and rely on processes of standardization (Carse 2017). These sociotechnical systems are designed, built, maintained, and can be disassembled. Howe et al. (2016) suggest that infrastructures are distinct in they are designed knowing that they will become obsolete and thus their construction is never finished. Within this definition, infrastructure includes built networks like water pipes and sewers, electricity grids, and roads, but it can also include “natural” landscapes, like forests, that are managed, invested in, destroyed, and reproduced (Carse 2014).

Infrastructure research, particularly those studies within political ecology, typically investigates how infrastructure is a product of and a contributor to political, economic, ecological, and social processes. Harvey and Knox (2015) argue that infrastructure is a product of entangled “social memory and future imaginaries” and that much work needs to be done to sort these out. Common research questions analyze how infrastructures reflect, reify, and/or challenge power relations, including how built infrastructure itself is both a product of and a contributor to uneven development (Swyngedouw 2015). Howe et al. (2016) theorize infrastructure by foregrounding its paradoxes – ruin (infrastructure is both generative and degenerative), retrofit (gives the

appearance of solidity but can be re-made and un-made), and risk (built to solve a problem but can create new problems).

Political ecologists have also grappled with the long-term implications and path dependencies of infrastructure (Carse 2014). Infrastructure is shaped by past decisions and shapes future decisions; similarly, infrastructure often implies large sunk costs that create inertia and inhibit change. Path dependency also creates financial legacies, often in the form of debt. In Greece, Marathon Dam was originally going to be built through a proposed tax on real estate, but political backlash prompted the government to court and use American investment money instead (Kaika 2006). As the first American investment into Greece, the investment opened the country to future foreign investments but also became a source of lingering debt. As of 1999, the project had still not been paid off. Notably, Monstadt (2006) extends the ideas of sunk costs of infrastructure beyond the simply financial. He argues that sunk costs include the large amounts of time and problem solving that go into planning, building, and maintaining infrastructure. This social cost of infrastructure can also inhibit change as stakeholders who invested time into the project may refuse to rethink or “undo” this work.

In sum, the infrastructure scholarship typically focuses on the social, ecological, and relational characteristics of infrastructure. The myths of infrastructure as purely utilitarian, politically neutral, and/or stable is dismissed and infrastructure is instead framed within broader historical and social trends. These methods include those that are typical within the broader political ecology field: extensive ethnographic field work, archival research, and interviews with decision makers and community residents. The

literature highlights that infrastructure is often invisible, except during moments of crisis or failure, but have important implications for how economic, environmental, and social processes are structured and their consequences.

Energy Communities and Infrastructure

Infrastructure is a defining characteristic in energy communities (e.g., Ryser et al. 2019; Tonts et al. 2013). Natural resource extraction requires large capital and infrastructure investments, both from companies looking to develop the resource and from local governments hoping to encourage the industry's development (Drache 1995). This is especially true in remote and rural geographies that have limited pre-existing infrastructure necessary to support rapid growth and new distribution needs prompted by industry (Gilmore 1976; Haggerty et al. 2018). Building and planning infrastructure in the context of resource booms involves a distinct set of challenges: uncertainty regarding the extent of population growth, time lags between when impacts occur and funding becomes available, and whether infrastructure should be built to accommodate peak demand or long-run averages (Cummings and Mehr 1977). Due to the scale and pace of UOG development, public infrastructure is often built rapidly and reactively (Grubert 2018), which can create its own set of cascading impacts that can persist into and beyond downturns in development.

From a socio-economic perspective, infrastructure investments can enhance quality of life in boomtowns but also increase fiscal risk when revenues are volatile. In the 1970s energy impacts literature, both Kohrs (1974) and Gilmore (1976) argued that infrastructure investments were needed to mitigate against social disruption. For example,

Kohrs (1974) specifically called for additional recreational facilities to help residents cope with rapidly increasing populations. However, there is often an assumption that municipalities in boomtowns receive enough revenues from resource development to mitigate impacts to infrastructure and public services, but this is not always the case (Enoch and Eaton 2018; Haggerty and Haggerty 2015; Newell and Raimi 2018). In some geographies, the costs of public infrastructure investments may outweigh the local benefits of resource development, particularly if tax breaks are given to industry (e.g., Drew et al. 2018; Tonts et al. 2013). This resource-return mismatch can create a paradox (de Souza et al. 2018): while infrastructure investments can be a strategy for retaining wealth from resource development, these investments can simultaneously create unsustainable long-term maintenance and debt service costs and/or entrench undesired path dependencies. Although public infrastructure investments are assumed to benefit both industry and the public, the actual benefits to the local community can be limited once industry leaves (Freudenburg 1992). Rural and remote communities with limited pre-existing infrastructure are particularly at risk for over-adapting to industry's need, an important variable in connecting infrastructure studies with economic geography's theorizing on resource peripheries and economic dependence.

References Cited in Chapter Two

- Adger, N. 2000. Social and ecological resilience: are they related? *Progress in Human Geography* 24: 347–64.
- Allred B. W., W. K. Smith, D. Twidwell, J. H. Haggerty, S. W. Running, D. E. Naugle, and S. D. Fuhlendorf. 2015. Ecosystem services lost to oil and gas in North America. *Science* 348: 401–2. doi:10.1126/science.aaa4785.
- Anderies, J. M., M. A. Janssen, and E. Ostrom. 2004. A framework to analyze the robustness of social-ecological systems from an institutional perspective. *Ecology and Society* 9 (1): 18.
- Appel, H., N. Anand, and A. Gupta. 2018. Introduction: temporality, politics, and the promise of infrastructure. In *The promise of infrastructure*, ed. N. Anand, A. Gupta, and H. Appel, 1–40. Durham, NC: Duke University Press.
- Argent, N. 2013. Reinterpreting core and periphery in Australia’s mineral and energy resources boom: an Innisian perspective on the Pilbara. *Australian Geographer* 44 (3): 323–40.
- Argent, N. 2016. Australia – trap or opportunity? Natural resource dependence, scale, and the evolution of new economies in the space/time of New South Wales’ Northern Tablelands. In *Transformation of resource towns and peripheries*, ed. G. Halseth, 18–50. New York: Routledge.
- Barnes, T. J., and B. Christophers. 2018. *Economic geography: a critical introduction*. Hoboken, NJ: John Wiley & Sons.
- Barnes, T. J., and R. Hayter. 2005. No “Greek-letter writing”: local models of resource economies. *Growth and Change* 36 (4): 453–70.
- Barnes, T. J., R. Hayter, and E. Hay. 2001. Stormy weather: cyclones, Harold Innis, and Port Alberni, BC. *Environment and Planning A* 33 (12): 2127–47.
- Berkes, F., and H. Ross. 2013. Community resilience: toward an integrated approach. *Society & Natural Resources* 26 (1): 5–20.
- Besser, T. L. 2013. Resilient small rural towns and community shocks. *Journal of Rural and Community Development* 8 (1): 117–34.
- Besser, T. L., N. Recker, and K. Agnitsch. 2008. The impact of economic shocks on quality of life and social capital in small towns. *Rural Sociology* 73 (4): 580–604.

- Blaikie, P. 1985. *The political economy of soil erosion in developing countries*. London: Longman.
- Bridge, G., J. McCarthy, and T. Perreault. 2015. Editors' introduction. In *The Routledge handbook of political ecology*, ed. T. Perreault, G. Bridge, and J. McCarthy, 3–18. New York: Routledge.
- Carpenter, S. R., B. H. Walker, J. M. Anderies, and N. Abel. 2001. From metaphor to measurement: resilience of what to what? *Ecosystems* 4: 765–81.
- Carse, A. 2014. *Beyond the big ditch: politics, ecology, and infrastructure at the Panama Canal*. Cambridge, MA: MIT Press.
- Carse, A., and J. A. Lewis. 2017. Toward a political ecology of infrastructure standards: or, how to think about ships, waterways, sediment, and communities together. *Environment and Planning A* 49 (1): 9–28.
- Christopherson, S. 2012. How should we think about the economic consequences of shale gas drilling? Paper presented at the Environmental and Social Implications of Hydraulic Fracturing and Gas Drilling in the United States: An Integrative Workshop for the Evaluation of the State of Science and Policy, Duke University, Durham, NC, January 9. <http://kansas.sierraclub.org/wp-content/uploads/2014/01/Duke-Presentation-Christopherson.pdf>.
- Coe, N. M., P. F. Kelly, and H. W. C. Yeung. 2020. *Economic geography: a contemporary introduction*. Hoboken, NJ: John Wiley & Sons.
- Cretney, R. 2014. Resilience for whom? Emerging critical geographies of socio-ecological resilience. *Geography Compass* 8/9: 627–40.
- Cummings, R. G., and A. F. Mehr. 1977. Investments for urban infrastructure in boomtowns. *Natural Resources Journal* 17.
- De Souza, S. V., B. Dollery, and B. Blackwell. An empirical analysis of mining costs and mining royalties in Queensland local government. *Energy Economics* 74 (2018): 656–62.
- Drache, D. 1995. Celebrating Innis: the man, the legacy, and our future. In *Staples, markets, and cultural change: Selected Essays*, ed. H. A. Innis and D. Drache, xiii–lix. Montreal: McGill-Queen's University Press.
- Drew, J., B. E. Dollery, and B. D. Blackwell. 2018. A square deal? Mining costs, mining royalties and local government in New South Wales, Australia. *Resources Policy* 55: 113–22.

- Emery, M., and C. Flora. 2006. Spiraling-up: mapping community transformation with community capitals framework. *Community Development* 37 (1): 19–35. doi:10.1080/15575330609490152.
- Enoch, S., and E. Eaton. 2018. A prairie patchwork: reliance on oil industry philanthropy in Saskatchewan boom towns. Canadian Centre for Policy Alternatives, Regina, SK.
- Erickson, J. D., and S. U. O’Hara. 2000. From top-down to participatory planning: conservation lessons from the Adirondack Park, United States. In *Biodiversity and ecological economics: participation, values, and resource management*, ed. L. Tacconi, 147–61. London: Earthscan Publications.
- Fleming, D., T. Komarek, M. Partridge, and T. Measham. 2015. The booming socioeconomic impacts of shale: a review of findings and methods in the empirical literature. Munich Personal RePEc Archive, 68487.
- Folke, C. 2006. Resilience: the emergence of a perspective for social–ecological systems analyses. *Global Environmental Change* 16 (3): 253–67.
- Folke, C. 2016. Resilience. *Oxford Research Encyclopedia of Environmental Science*: 1–68. doi:10.1093/acrefore/9780199389414.013.8.
- Freudenburg, W. R. 1992. Addictive economies: extractive industries and vulnerable localities in a changing world economy. *Rural Sociology* 57 (3): 305–32.
- Gilmore, J. S. 1976. Boom towns may hinder energy resource development. *Science* 191 (4227): 535–40.
- Grubert, E. 2018. The Eagle Ford and Bakken shale regions of the United States: a comparative case study. *The Extractive Industries and Society* 5 (4): 570–80.
- Haarstad, H., and T. I. Wanvik. 2017. Carbonscapes and beyond: conceptualizing the instability of oil landscapes. *Progress in Human Geography* 41 (4): 432–50.
- Haggerty, J., and K. McBride. 2016. Does local monitoring empower fracking host communities? A case study from the gas fields of Wyoming. *Journal of Rural Studies* 43: 235–47.
- Haggerty, M. N., and J. H. Haggerty. 2015. Energy development as opportunity and challenge in the rural west. In *Bridging the distance*, ed. D. Danbom, 161–90. Salt Lake City: University of Utah Press.
- Halseth, G., and L. Ryser. 2006. Trends in service delivery: examples from rural and small town Canada, 1998 to 2005. *Journal of Rural and Community Development* 1 (2).

- Halseth, G., and L. Ryser. 2017. *Towards a political economy of resource-dependent regions*. New York: Routledge.
- Halseth, G. 2016. Introduction: political economy perspectives on the transformation of resource towns and peripheries. In *Transformation of resource towns and peripheries*, ed. G. Halseth, 1–10. New York: Routledge.
- Harrison, J. L., C. A. Montgomery, and J. C. Bliss. 2016. Beyond the monolith: the role of bonding, bridging, and linking social capital in the cycle of adaptive capacity. *Society & Natural Resources* 29 (5): 1–15.
- Harvey, D. 2001. *Spaces of capital: towards a critical geography*. New York: Routledge.
- Harvey, D. 2005. *A brief history of neoliberalism*. Oxford: Oxford University Press.
- Harvey, P., and H. Knox. 2015. *Roads: an anthropology of infrastructure and expertise*. Ithaca, NY: Cornell University Press.
- Hayter, R., T. J. Barnes, and M. J. Bradshaw. 2003. Relocating resource peripheries to the core of economic geography's theorizing: rationale and agenda. *Area* 35 (1): 15–23.
- Hibbard, M., and S. Lurie. 2015. The new natural resource economy: a framework for rural community resilience. In *Bridging the distance: common issues of the rural West*, ed. D. Banborn, 192–210. Salt Lake City: University of Utah Press.
- Hitaj, C., A. Boslett, and J. G. Weber. 2014. Shale development and agriculture. *Choices* 29 (4).
- Holling, C. S. 1973. Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics* 4: 1–23.
- Holling, C. S. 1986. The resilience of terrestrial ecosystems: local surprise and global change. In *Sustainable development of the biosphere: interactions between the world economy and the global environment*, ed. W. C. Clark. 292–317. Cambridge, UK: Cambridge University Press.
- Holling, C. S., and S. M. Sundstrom. 2015. Adaptive management, a personal history. In *Adaptive management of social-ecological systems*, ed. A. S. Garmestani and C. R. Allen, 11–25. Dordrecht: Springer.
- Howe, C., J. Lockrem, H. Appel, E. Hackett, D. Boyer, R. Hall, M. Schneider-Mayerson, A. Pope, A. Gupta, E. Rodwell, et al. 2016. Paradoxical infrastructures: ruins, retrofit, and risk. *Science Technology & Human Values* 41 (3): 547–65.

- Huber, M. 2015. Energy and social power: from political ecology to the ecology of politics. In *The Routledge handbook of political ecology*, ed. T. Perreault, G. Bridge, and J. McCarthy, 481–92. New York: Routledge.
- Jacquet, J. 2014. Review of risks to communities from shale energy development. *Environmental Science & Technology* 48 (15): 8321–33.
- Jacquet, J. B., and D. L. Kay. 2014. The unconventional boomtown: updating the impact model to fit new spatial and temporal scales. *Journal of Rural and Community Development* 9 (1): 1–23.
- Jacquet, J. B., K. Witt, W. Rifkin, and J. H. Haggerty. 2018. A complex adaptive system or just a tangled mess? Property rights and shale gas governance in Australia and the US. In *Governing shale gas*, ed. J. Whitton, M. Cotton, I. M. Charnley-Parry, and K. Brasier, 55–68. New York: Routledge.
- Jacquet, J. B. 2015. The rise of ‘private participation’ in the planning of energy projects in the rural United States. *Society & Natural Resources* 28 (3): 231–45.
- Jacquet, J. 2009. Energy boomtowns & natural gas: implications for Marcellus shale local governments & rural communities. NERC RD Rural Development 43. Northeast Regional Center for Rural Development, University Park, PA.
<http://energy.wilkes.edu/PDFFiles/Issues/Energy%20Boomtowns%20and%20Natural%20Gas.pdf>.
- Kaika, M. 2005. *City of flows: modernity, nature, and the city*. New York: Routledge.
- Kelsey, T., M. Partridge, and N. White. 2014. Unconventional gas and oil development in the United States: economic experience and policy issues. *Applied Economics Perspectives and Policy* 38 (2): 191–214.
- Kohrs, E. V. 1974. Social consequences of boom growth in Wyoming. Paper presented at the Rocky Mountain American Association of the Advancement of Science Meeting, Laramie, Wyoming, April 24–26.
<http://www.sublettewyo.com/Archive/ViewFile/Item/97>.
- Konschnik, K. E., and M. K. Boling. 2014. Shale gas development: a smart regulation framework. *Environmental Science & Technology* 48 (15): 8404–16.
- Kulig, J., D. S. Edge, I. Townshend, N. Lightfoot, and W. Reimer. 2013. Community resiliency: emerging theoretical insights. *Journal of Community Psychology* 41 (6): 758–75. doi:10.1002/jcop.21569.
- Magis, K. 2010. Community resilience: an indicator of social sustainability. *Society and Natural Resources* 23: 401–16. doi:10.1080/08941920903305674.

- Malin, S. A., and K. T. DeMaster. 2016. A devil's bargain: rural environmental injustices and hydraulic fracturing on Pennsylvania's farms. *Journal of Rural Studies* 47: 278–90.
- Martin, R., and P. Sunley. 2014. On the notion of regional economic resilience: conceptualisation and explanation. *Journal of Economic Geography* 15 (1): 1–42. doi:10.1093/jeg/lbu015.
- McCarthy, J. 2002. First World political ecology: lessons from the Wise Use movement. *Environment and Planning A* 34 (7): 1281–1302.
- McNally, R. 2017. *Crude volatility: the history and the future of boom-bust oil prices*. New York: Columbia University Press.
- Measham, T. G., D. A. Fleming, and H. Schandl. 2016. A conceptual model of the socioeconomic impacts of unconventional fossil fuel extraction. *Global Environmental Change* 36: 101–10.
- Meehan, K. M. 2014. Tool-power: water infrastructure as wellsprings of state power. *Geoforum* 57: 215–24.
- Monstadt, J. 2009. Conceptualizing the political ecology of urban infrastructures: insights from technology and urban studies. *Environment and Planning A* 41 (8): 1924–42.
- Morrison, T. H. 2016. The meta-governance of regions and the need for a political geography of planning. *International Planning Studies* 21 (3): 298–304.
- Nelson, S. H. 2014. Resilience and the neoliberal counter-revolution: from ecologies of control to production of the common. *Resilience: International Policies, Practices and Discourses* 2: 1–17.
- Newell, R. G., and D. Raimi. 2018. The fiscal impacts of increased US oil and gas development on local governments. *Energy Policy* 117: 14–24.
- Norris, F., S. Stevens, B. Pfefferbaum, K. Wyche, and R. Pfefferbaum. 2008. Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology* 41 (1): 127–50. doi:10.1007/s10464-007-9156-6.
- O'Sullivan, M. L. 2017. *Windfall: how the new energy abundance upends global politics and strengthens America's power*. New York: Simon and Schuster.
- Olien, R. M., and D. D. Olien. 1982. *Oil booms: social change in five Texas towns*. Lincoln: University of Nebraska Press.

- Parrott, L., C. Chion, R. Gonzalès, and G. Latombe. 2012. Agents, individuals, and networks: modeling methods to inform natural resource management in regional landscapes. *Ecology and Society* 17 (3). doi:10.5751/ES-04936-170332.
- Peck, J., and A. Tickell. 2002. Neoliberalizing space. *Antipode* 34 (3): 380–404.
- Peterson, G. 2000. Political ecology and ecological resilience: an integration of human and ecological dynamics. *Ecological Economics* 35 (3): 323–36. doi:10.1016/S0921-8009(00)00217-2.
- Pike, A., A. Rodriguez-Pose, and J. Tomaney. 2006. *Local and regional development*. New York: Routledge.
- Rabe, B. G. 2014. Shale play politics: the intergovernmental odyssey of American shale governance. *Environmental Science & Technology* 48 (15): 8369–75.
- Raimi, D. 2017. *The fracking debate: the risks, benefits, and uncertainties of the shale revolution*. New York: Columbia University Press.
- Rifkin, W., K. Witt, J. Everingham, and V. Uhlmann. 2015. Benefits and burdens for rural towns from Queensland's onshore gas development. Paper presented at the SPE Asia Pacific Unconventional Resources Conference and Exhibition, Society of Petroleum Engineers, Brisbane, Australia, November 9–11.
- Robbins, P. 2012a. *Lawn people: how grasses, weeds, and chemicals make us who we are*. Philadelphia: Temple University Press.
- Robbins, P. 2012b. *Political ecology*. 2nd ed. Vol. 16. West Sussex, UK: John Wiley & Sons.
- Robertson, M. 2015. Environmental governance: political ecology and the state. In *The Routledge handbook of political ecology*, ed. T. Perreault, G. Bridge, and J. McCarthy, 457–66. New York: Routledge.
- Robinson, L. W., and F. Berkes. 2011. Multi-level participation for building adaptive capacity: formal agency-community interactions in northern Kenya. *Global Environmental Change* 21: 1185–94.
- Ross, M. L. 1999. The political economy of the resource curse. *World Politics* 51 (2): 297–322.
- Ryser, L., G. Halseth, S. Markey, C. Gunton, and N. Argent. 2019. Path dependency or investing in place: understanding the changing conditions for rural resource regions. *The Extractive Industries and Society* 6 (1): 29–40.

- Sachs, J., and A. Warner. 1995. Natural resource abundance and economic growth. NBER Working Paper No. 5398. National Bureau of Economic Research, Cambridge, MA.
- Silva, T. J., and J. A. Crowe. 2015. The hope-reality gap: rural community officials' perceptions of unconventional shale development as a means to increase local population and revitalize resource extraction. *Community Development* 46 (4): 312–28.
- Small, M. J., P. C. Stern, E. Bomberg, S. M. Christopherson, B. D. Goldstein, A. L. Israel, R. B. Jackson, A. Krupnick, M. S. Mauter, J. Nash, et al. 2014. Risks and risk governance in unconventional shale gas development. *Environmental Science & Technology* 48 (15): 8289–97.
- Smith, A., and A. Stirling. 2010. The politics of social-ecological resilience and sustainable socio-technical transitions. *Ecology and Society* 15 (1).
- Smith, K. K., and J. H. Haggerty. 2018. Devolved governance & alternative dispute resolution programs: An example from the Bakken. In *Governing shale gas: development, citizen participation and decision making in the US, Canada, Australia and Europe*, ed. K. Brasier, M. Cotton, and J. Whitton, 184–97. London: Routledge.
- Smith, K. K., and J. H. Haggerty. 2020. Exploitable ambiguities and the unruliness of natural resource dependence: public infrastructure in North Dakota's Bakken Shale Formation. *Journal of Rural Studies*.
<https://doi.org/10.1016/j.jrurstud.2020.05.006>.
- Smith, M. D., R. S. Krannich, and L. M. Hunter. 2001. Growth, decline, stability, and disruption: a longitudinal analysis of social well-being in four western rural communities. *Rural Sociology* 66 (3): 425–50.
- St. Martin, K. 2001. Making space for community resource management in fisheries. *Annals of the Association of American Geographers* 91 (1): 122–42.
- Stedman, R. C., J. R. Parkins, and T. M. Beckley. 2004. Resource dependence and community well-being in rural Canada. *Rural Sociology* 69 (2): 213–34.
- Swyngedouw, E. 2015. *Liquid power: contested hydro-modernities in twentieth-century Spain*. Cambridge, MA: MIT Press.
- Tonts, M., K. Martinus, and P. Plummer. 2013. Regional development, redistribution and the extraction of mineral resources: the Western Australian Goldfields as a resource bank. *Applied Geography* 45: 365–74.

- Trainor, A. M., R. I. McDonald, and J. Fargione. 2016. Energy sprawl is the largest driver of land use change in United States. *PloS one* 11 (9).
- Turner, M. D. 2014. Political ecology I: an alliance with resilience? *Progress in Human Geography* 38 (4): 616–23.
- Walker, B., and D. Salt. 2006. *Resilience thinking*. Washington, DC: Island Press.
- Walker, B., and D. Salt. 2012. *Resilience practice: building capacity to absorb disturbance and maintain function*. Washington, DC: Island Press.
- Walker, P. A. 2003. Reconsidering “regional” political ecologies: toward a political ecology of the rural American West. *Progress in Human Geography* 27 (1): 7–24.
- Walker, R. A. 2001. California’s golden road to riches: natural resources and regional capitalism 1848–1940. *Annals of the Association of American Geographers* 91 (1): 167–99.
- Wallerstein, I. 2004. *World-systems analysis*. Durham, NC: Duke University Press.
- Walsh-Dilley, M., W. Wolford, and J. McCarthy. 2016. Rights for resilience: food sovereignty, power, and resilience in development practice. *Ecology and Society* 21 (1): 11.
- Warner, M. E. 2010. The future of local government: twenty-first-century challenges. *Public Administration Review* 70.
- Watts, M. J. 1983. *Silent violence: food, famine, and peasantry in northern Nigeria*. Berkeley: University of California Press.
- Wilkinson, C. 2011. Social-ecological resilience: insights and issues for planning theory. *Planning Theory* 11 (2): 148–69. doi:10.1177/1473095211426274.
- Wilkinson, T. 1982. Environmental programme for offshore oil operations. *Chemistry and Industry* 4: 115–23.
- Wilson, C. E., T. H. Morrison, J-A. Everingham, and J. McCarthy. 2017. Steering social outcomes in America’s energy heartland: state and private meta-governance in the Marcellus shale, Pennsylvania. *American Review of Public Administration* 47 (8): 929–44.
- Wilson, G. 2012. *Community resilience and environmental transitions*. New York: Routledge.

- Witt, K., J. Whitton, and W. Rifkin. 2018. Is the gas industry a good neighbour? A comparison of UK and Australia experiences in terms of procedural fairness and distributive justice. *The Extractive Industries and Society* 5 (4): 547–56.
- Woods, M., and M. Goodwin. 2003. Applying the rural: governance and policy in rural areas. In *Country visions*, ed. P. J. Cloke, 245–62. London: Pearson.
- Woods, M. 2005. *Rural geography: processes, responses and experiences in rural restructuring*. London: Sage.
- Zirogiannis, N., J. Alcorn, J. Rupp, S. Carley, and J. D. Graham. 2016. State regulation of unconventional gas development in the US: an empirical evaluation. *Energy Research & Social Science* 11: 142–54.

CHAPTER THREE

THE BAKKEN: A PHOTO ESSAY

The photo essay is available as a supplemental document to this dissertation and can also be viewed at www.ksmithresearch.com/photoessay.

CHAPTER FOUR

DEVOLVED GOVERNANCE AND ALTERNATIVE DISPUTE

RESOLUTIONS: AN EXAMPLE FROM THE BAKKEN

Contribution of Authors and Co-Authors

Author: Kristin K. Smith

Contributions: Kristin Smith developed the research question and approach. She collected and analyzed the data for the research, and then wrote the manuscript.

Co-Author: Julia H. Haggerty

Contributions: Julia Haggerty supervised the project, offering feedback on the research's development and findings. She also edited the manuscript.

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Introduction

Shale governance strategies in the United States have been works in progress over the past decade, with policy development often occurring in response to emergent impacts and local concerns. As most shale development in the United States involves non-federal land where the federal government has opted to provide few policy guidelines, management of surface impacts focuses on state, local, and non-governmental domains. This devolution in policy scale creates an opportunity to reflect on the costs and benefits of localized solutions to shale governance—a trend also apparent in non-US contexts such as Australia and Canada. Devolved strategies have the potential to accommodate local context, something of merit, given the wide variety in geographies of shale development in the United States. However, given the power imbalance between local stakeholders and the oil and gas industry, the risk of regulatory capture is a real concern in devolved governance. In addition, governance can create substantial uncompensated burdens for local stakeholders, raising additional questions about equity. This chapter takes up the tradeoffs involved in devolved shale governance through a case study of a landowner association in north-western North Dakota, the location of the Bakken shale oil play, and its associated oil boom from the mid-2000s through 2014.

The character of the Bakken boom as an environmental, social, and political phenomenon is heavily shaped by the rural nature of western North Dakota and eastern Montana, where farmers and tribal nations are the major landowners and high value small grains production and extensive livestock ranching are the dominant land uses. As a result of this agriculture-energy overlay, rural landowners and farmers are first-order

stakeholders in the impacts of a decade of infrastructure expansion involving construction of thousands of new wells, new roads and/or road upgrades, well pads, storage fields, processing facilities, transportation hubs, and miles upon miles of gathering lines and transmission pipelines. Formed in 2009, the Northwest Landowners Association (NWLA) in North Dakota has emerged as an influential force in the development of governance in response to the surface impacts of shale development, especially though not exclusively in the arena of pipeline construction impacts.

Through detailed profiles of three key members in the Northwest Landowners Association (NWLA) and their work on a specific program to address pipeline impacts, this chapter explores the strategies developed by NWLA and their implications both for leaders of the organization and for the landowners they represent. This approach allows for a discussion of how devolved approaches to surface impact management present opportunities and challenges for landowners that host energy development in rural areas. Specifically, the analysis addresses the tensions in maintaining an accommodating approach toward industry while attempting to advocate effectively for landowner interests, as well as familiar questions about the costs of devolved governance strategies, with respect to their efficacy and high dependence on individuals.

Shale Governance and Alternative Dispute Resolution Programs

Shale Governance

The unique property rights regime and the political and economic context in the United States create a complicated and challenging scenario from the perspective of regulating unconventional fossil fuel (UFF) as a form of industrial development (Jacquet & Kay,

2014; Small et al., 2014; Whitton, Brasier, Charnley-Parry, & Cotton, 2017). Due to a political economy that favors privatization, deregulation, and delegation (Harvey, 2005; Levi-Faur, 2005), the majority of UFF development activities in the US, such as land use planning, waste management, drilling, and so forth, occurs at the state level, where the scope and nature of regulation can vary wildly from one place to the next (Warner & Shapiro, 2013; Zirotiannis, Alcorn, Rupp, Carley, & Graham, 2016). What results is a “halting patchwork of rules” frustrating industry on the one hand (Konschnik & Boling, 2014, p. 1), and a dispersed, uncoordinated assemblage of regulations, regulators, and responsible parties, frustrating landowners and communities on the other (Haggerty & Haggerty, 2015).

Within this challenging regulatory system, landowners often have limited opportunities to impact governance systems (Whitton et al., 2017). (We use the notion of governance as governing through multi-stakeholder/multi-sectoral collaboration and non-statutory strategies (Bridge & Perreault, 2009)). In response, landowners in various energy development contexts have created associations, coalitions, and taskforces that seek to empower landowners through a variety of means. Landowner groups take on various roles, ranging from sharing resources and information to forming bargaining units to negotiate collective leases (Balliet, 2008). Drawing comparisons to forest and agriculture cooperatives, Jacquet and Stedman (2011) argue that landowner associations are often formed to maximize members’ individual benefits but can have broader positive effects on the community, such as helping to protect watersheds or fragile ecosystems.

The Northwest Landowners Association (NWLA) is an example of one such landowner association, representing an important exception to a general trend of limited landowner organizing in the Bakken. This is in contrast to other regions, such as the Marcellus Shale Play and the Powder River Basin, where landowner collective advocacy and management are more evident (Brasier et al., 2011; Jacquet & Stedman, 2011; Klassen & Feldpausch-Parker, 2011). NWLA formed in 2009 in response to a proposed wind development, but the organization has continually adapted to address the needs of landowners impacted by the Bakken shale boom. As of 2016, NWLA had 477 due-paying members. A key transition in the group's evolution is its increasing focus on negotiating and lobbying for state policy changes. It gained 501(c)(6) status in 2012, a legal mechanism that allows NGOs in the United States to maintain tax-free status while actively lobbying to influence political processes. Since then, NWLA has effectively advocated for policy changes regulating oil and gas development at the state level. This is perhaps due to NWLA's conscious strategy of collaborating with – rather than antagonizing – the shale industry.

The Pipeline Restoration and Reclamation Oversight Program, known as the pipeline ombudsman program, is an outcome of this focus and strategy. As pipeline construction scaled up alongside UFF production during the Bakken boom, farmers and ranchers increasingly experienced problems with reclamation during and after pipeline construction phases. This led to a perceived wariness among landowners to continue signing easements—e.g., a risk to the industry's social license to operate (SLO). To address this emerging conflict, NWLA partnered with the North Dakota Department of

Agriculture and the energy industry to propose the Pipeline Restoration and Reclamation Oversight Pilot Program. NWLA's lobbying resulted in the program being funded in 2015.

The pipeline ombudsman program sits within the state's Department of Agriculture. Landowners with pipeline reclamation issues on their land can request assistance from the Department, who will then assign the landowner a local ombudsman. The ombudsman meets with the landowner and the pipeline company to help facilitate a solution to the problem and avoid litigation. The goal is to develop a collaborative plan, timeline, and monitoring agreement to address the issue(s). From April 2015 to November 2016, the Department received 55 official complaints. Common issues included unsatisfactory reclamation efforts (rough or uneven ground and/or incomplete re-vegetation), loss of topsoil, and introduction of weeds (Junkert and Goehring 2016). Of the 55 complaints filed, all of them but one resulted in successful negotiations, with the negotiation process lasting anywhere from several days to over two years.

Global Approaches to Alternative Dispute Resolution

North Dakota's pipeline ombudsman program is an example of a trend emerging globally: alternative dispute resolution programs that seek to foster voluntary solutions to problems between the energy industry and landowners. Both Alberta and Queensland have alternative dispute resolution programs for landowner-energy conflicts. The Alberta Energy Regulator's (AER) Alternative Dispute Regulation was developed, according to its manual, "in response to the desire of AER stakeholders to be more directly involved and have more control in resolving disputes" (Alberta Energy Regulator, 2013, p. 1).

Between 2012 and 2016, the AER's successful resolution rate for disputes ranged from 80–95 percent (Alberta Energy Regulator, 2016). Similarly, in Queensland, in response to the coal seam gas (CSG) boom, a bill was introduced in 2017 to form a land access ombudsman. The program was proposed after a review of the Gasfields Commission found that “landholders expressed an overwhelming sense of powerlessness” (Scott, 2016, p. 6). Notably, the Australian Petroleum Production & Exploration Association (APPEA), Australia's top oil and gas industry group, is in favor of the legislation, citing the need for industry and landholders to have a “balanced, timely, transparent, and accessible process to resolve [disputes]” (Murphy, 2017, para. 6).

The emergence of ombudsman programs and alternative dispute resolution mechanisms emphasizes the role of devolved, non-regulatory approaches to addressing surface impacts from shale development. Alternative dispute resolution strategies are classic examples of governance solutions that hinge on a range of stakeholders operating through non-regulatory mechanisms. The success of these approaches may be influential in the maintenance of SLO by industry. Building trust and having high-quality, meaningful engagement with stakeholders are key determinants of SLO (Moffat & Zhang, 2014)—and trust and meaningful engagement are critical to both the development of and implementation of governance solutions, such as these alternative dispute mechanisms. This chapter explores why key NWLA members decided to lobby for the ombudsman program and some of the tensions that arise when landowners use industry's desire and need for SLO to create governance solutions.

Methods

This chapter focuses on the history and evolution of NWLA from the perspective of key members who contributed to the organization's lobbying for the state's pipeline ombudsman program. NWLA was selected as a case study based on consultation with local stakeholders who identified the organization as having a large impact on state policy. To develop the organization's history, we employed a mixed method approach. First, we conducted document analysis using the organization's materials as well as regional news media coverage, which helped inform our interview script. We next conducted in-depth interviews with five key NWLA members. Four of the interviews were conducted in person during May 2016 and the final interview was performed the following month over the phone. Interviews were semi-structured, meaning they followed a script but the interviewer was also given the "freedom to digress" to explore emerging themes (Berg & Lune, 2004, p. 61). Three of the interviewees were farmers or ranchers with energy development on property that they owned, one was a rancher dealing with energy development on leased land, and the final interviewee was instrumental in the organization's operations but was neither a farmer nor a rancher. The organization's leadership identified our interviewees. We do not claim that the material developed here represents the full suite of NWLA members' experiences but rather a range of opportunities and challenges in mitigating impacts from shale development through landowner organizing from the perspective of the organization's core members.

Interviews were in-depth with the shortest taking 51 minutes and the longest lasting two hours and 52 minutes; the average interview lasted one hour and 40 minutes.

After collecting the data, interviews were transcribed verbatim using a professional transcriber. Transcriptions were coded by hand. Through repeated readings of the transcripts, we highlighted and categorized emerging themes, collapsing and expanding codes as needed (Lindlof, 1995). Three of the interviews were crafted into in-depth profiles due to their close involvement with both NWLA and pipeline issues. To provide anonymity, their names have been changed. We used the narratives presented here to build toward an inventory of the diverse ways that landowner coalitions benefit and challenge the needs of individual landowners in energy development contexts.

Profiles of Members of the Northwest Landowners Association

Profile 1. Ellen: “I wasn’t looking to create chaos in my own personal life, but I just felt like somebody needed to step up...”

Ellen grew up in north-western North Dakota and returned to the area with her husband and children during the beginning of the shale boom. Instead of finding the quiet, pastoral life she envisioned for her family, she moved to a community undergoing an immense amount of development. Or, as she explained, “I don’t even call it development because it wasn’t managed at all, just this rapid growth.” She was particularly frustrated with how the benefits and costs of shale development were distributed unequally throughout the state and noted that the revenue her county received did not cover the full costs of impacts. She questioned the large tax breaks energy companies received, given her perception of the high costs on local landowners from energy-related impacts: “There’s just these trickle-down impacts [so] that the cost of doing business gets pushed on to the agriculture community, who does pay property taxes

[sic].” In addition to these broader frustrations, Ellen’s neighbors started complaining about interactions with landmen and sharing concerns about leases.

Ellen represents the perspective of landowners dealing with energy development but not receiving the royalties from production—the mineral rights below her ranch had long ago been sold to private parties outside her family. When a landman approached Ellen about a surface use agreement, she refused to sign and felt that she lacked power in negotiations as a non-mineral rights owner. Afterward, Ellen helped to start a local landowner association, which was later subsumed within NWLA. She was also elected to public office. When questioned about why she didn’t sign the agreement and why she started to organize landowners, she stated:

I wasn’t looking for volunteer work. I wasn’t looking to create chaos in my own personal life, but I just felt like somebody needed to step up and start talking about this and just not get distracted by the checks and the promises, and so I did that.

This story simultaneously explains why Ellen became a member of NWLA while also emphasizing the toll her involvement in managing energy impacts has taken on her personal life; the “chaos” that she has experienced.

Before NWLA existed, landowners in Ellen’s community had limited options for voicing their concerns related to UFF development. While many landowners were members of larger state associations like the North Dakota Farmers Union or the North Dakota Farm Bureau, these organizations did not directly address energy issues. According to Ellen, NWLA was the first organization in her region that “focus[ed] on surface rights as they intersect[ed] with energy development, the mineral aspect, and that our surface and our minerals are by a majority segregated.” When asked about the

organization's role with regards to policy, she described how the mission expanded to include regulatory issues:

The mission really is to educate and through that educational process I think people are starting to realize that there are some very deficient areas in our state law or in our administrative rules in the different departments that oversee development.

Ellen believes that NWLA became more actively involved with lobbying for governance solutions due to members' perceptions that state regulations were inadequate and/or did not address landowner concerns.

To help mitigate negative impacts from pipeline development, Ellen advocated for a local pipeline ombudsman program. As she explains, "people were just really exhausted [due to problems with pipeline operations] and didn't want to continue to sign easements and allow right of ways." In response, the conservation district for Ellen's region proposed an ombudsman program. At the same time, an alternative plan had evolved to develop a statewide ombudsman program. "There were these two concepts, go very local or go from state down." NWLA, as an organization, supported the statewide plan. Ellen disagreed, convinced that only the local conservation district had the requisite experience with the highly erodible soils and sparse population that posed unique challenges to reclamation for her and her neighbors. Ultimately the statewide plan won the funding, eclipsing the proposal for a conservation district-scale program.

The tensions about the appropriate scale of the ombudsman program highlight several complexities in landowner organizing for policy change and governance solutions. While Ellen felt the conservation district would result in the most effective alternative dispute resolution program, NWLA leadership worried that creating multiple,

local pipeline ombudsman programs could result in inconsistent services for their members. Ellen remains involved in NWLA, but regrets the choice to pursue a state rather than a local ombudsman program. From her perspective, NWLA's statewide approach not only created a tradeoff between administrative efficiency and innovation in reclamation strategies, but also reduced local involvement in the program. Ellen attributed the low program participation among her neighbors to general mistrust of state agencies. Given the consequences of poor enrollment in the program, this is a key observation about the importance of scale in local shale governance strategies. According to Ellen, the statewide approach and its tradeoffs have resulted in unaddressed pipeline impacts in her community.

Profile 2. Jim: "We're not there representing anyone else. We're representing ourselves ... we're living it."

Jim has lived in northwestern North Dakota his entire life. Before starting his farm, he worked in the energy sector during the 1970s oil boom to help save money to buy his farmland. While Jim is in favor of UFF extraction, he experienced negative impacts from recent development on his land and, like Ellen, felt mistreated by landmen. After describing how the increases in heavy truck traffic damaged roads near his farm, he said, "We're mad. We're fighting it. We just don't like it, and we're crabby." In another story, Jim voiced his frustration about the energy companies' failure to take local knowledge seriously. When an oil company proposed a well on a neighbor's nearby farm, his friend informed the contractors that the location was frequently flooded in the spring during snow melts. The company continued construction until the pad was flooded in the

spring, and they had to move it. Jim noted, “They had no idea what’s there ... so when you see things like that you think, ‘Oh my God.’ It bugs you, but that’s the way things are.”

Given these frustrations, the Northwest Landowners Association provided Jim an outlet to make changes to a system that he considers flawed:

We’re at the point where we adapted and got used to it, and it ain’t going away. I can fight it and be mad forever, or I can try to make it work better. It was sometime in there ... [that] I got involved with Northwest Landowners.

Jim wants to accommodate industry but in ways that work for farmers and ranchers. To do so, he became heavily involved with NWLA’s lobbying efforts. In 2015, Jim estimated that he spent over 35 days in the state capitol lobbying during the 64th legislative session. The pipeline ombudsman program was a major policy win for NWLA during this session. When asked how NWLA decided to focus on the ombudsman program, Jim answered, “Whatever our members come with, that’s what we’re going to fight for. And reclamation is the big one, reclamation of pipelines.” As a lobbyist for NWLA, Jim understands his role as being a collective voice for the members.

To help pass the ombudsman bill, Jim described how NWLA strategically cultivated relationships with industry over many years, which, according to Jim, marked a shift from earlier approaches:

So many people are anti-everything else. It’s my way or no way ... And, that’s the way we started. Northwest Landowners started with that view of you guys are the bad guys. Oil is the bad guy; we’re the good guys. We care about the land. That got us nowhere.

Jim described NWLA’s current strategy as being more solution-oriented and collaborative. To illustrate this shift in tactics, he compared NWLA to another

organization working on shale development issues, the Dakota Resource Council (DRC). In describing the DRC's approach to advocacy, he explained, "[T]hey have a bad reputation of being very negative, very controversial." This strategy, he explained, hinders their ability to create change. "[T]hey do not have a good name. In fact, they're discounted. We've had industry and state people tell us that they're not a factor anymore." In contrast, NWLA is effective because they position themselves as part of a collaborative solution between industry and landowners. Jim reiterated this throughout the interview by explaining that he could call industry representatives or government officials when he needed advice or wanted to report a problem.

After the ombudsman bill passed, Jim felt that NWLA was increasingly seen as important stakeholders on policy issues: "I don't want to sound like I'm bragging, but things just went really good for us last session. We get invited to the table a lot ... so they're asking us what we think!" Later in the interview, however, he described the NWLA as being constrained by the UFF industry's power. When he reflected back on his first session lobbying, he suggested that they only succeeded with their early proposals because the industry representatives allowed them to: "[the UFF industry] threw us some bones so we could say, 'Yeah, we got something.'" Throughout the interview, Jim was proud of NWLA's achievements but also aware of the power dynamics that shaped what the organization was able or unable to accomplish.

Jim's accounts of his involvement with the organization point to the power of NWLA to be both empowering and exhausting for members. Jim is proud of his volunteer efforts to help create the alternative dispute resolution program, as well as his

efforts to educate landowners and industry representatives about pipeline reclamation and landowner associations. He also enjoyed having direct access to industry representatives. Despite these benefits, he is at times skeptical of NWLA's impact and often made off-hand comments about getting tired of the process: "That's why I go to [the state capitol], because I have to. Try to get other people, but there's no one else..." During a follow-up interview a year after first talking with Jim, he was no longer involved with NWLA. Jim's empowerment through NWLA and subsequent fatigue with the process speak to larger opportunities and challenges of participating in a landowner association to manage energy impacts.

Profile 3. Garret: "Now these get documented to the state, which is very, very important."

The final profile is of Garret, a farmer who heard about NWLA from Jim. Garret has over 80 miles of pipeline beneath his fields. When we talked with him, he was dealing with three pipeline reclamation problems, and he noted several other minor but unresolved issues. According to Garret, "We could literally hire someone on a full-time basis just to work with oil field issues, a 40-hour week, every week, every month all summer long, most of the winter." Garret attributed his negative experiences with pipelines to his initial lack of knowledge about leasing negotiations and contracts. When asked why he decided to get involved with NWLA, he stated:

All these pipeline issues have to do with signing leases and how your lease is structured. Here's how the oil field works. They move into a new area. We're all brand new at this, and we think, "100% for it!" I just was thrilled about it because here's our pathway to energy independence. But they move into an area where nobody knows anything and they just run over the top of you. And they did to the point where something has to be done. The only way to stop that is to be affiliated with a group.

In another example, an energy company proposed building a storage and transportation facility next to his farm but failed to identify the project's full range of risks. After it was completed, Garret felt the project did not meet his expectations:

So now we have this pipeline to take trucks off the road, but guess where the trucks are going to come? Right here! So what's the use? They don't lie. They just don't tell you, and you don't know the right questions to ask. That's why it's important to get a hold of landowner groups that have already been there.

Both statements reveal a belief that landowner organizations are important not only to mitigate impacts, but also in addressing systemic knowledge and power imbalances between individual landowners and energy companies.

Garret cited the state's regulations as reinforcing these imbalances instead of helping to protect landowners, an example of regulatory capture. He explained, "[the] oil field does whatever they want to do. The state of North Dakota has given them tacit approval to do whatever they need to do to get the money because they want money." He attributed this lack of regulation to disconnections between statewide legislatures and the localized impacts experienced in northwestern North Dakota. Since energy tax revenues are redistributed statewide, legislators from other regions benefit from new sources of revenue and thus have little incentive to propose regulations to manage growth. Garret argued, "What do you think [the state legislators] think? They think this is a gold mine. They don't want to slow it down." Garret particularly felt disempowered when he went to the statehouse to testify about energy development impacts: "We got told, without saying so, we got told in no uncertain terms that we didn't matter." Again, Garret's comments speak to a form of regulatory capture in which state regulations fail to address entrenched power and knowledge imbalances between industry and the public.

Given the lack of regulation and landowners' limited knowledge about the legal and regulatory system, Garret encouraged landowners to join a group like NWLA to help manage impacts. He noted, "having a group like [NWLA] that's in touch with other groups gets you up to speed faster." In addition to knowledge sharing, Garret appreciated NWLA's ability to monitor policy proposals and negotiations. Even in years without legislative sessions, he noted, "[NWLA members] are monitoring everything that goes on." While Garret often commented that he would like state legislatures and industry to be more proactive, he relied on NWLA to make his own voice heard and to act as a watchdog at the statehouse by monitoring policies.

Notably, Garret has directly benefited from the statewide pipeline ombudsman program. When Garret's fields developed large holes due to inadequate reclamation and none of the pipeline companies would claim responsibility, he used the ombudsman program to negotiate solutions. Before the ombudsman program, landowners would have had limited options, besides litigation, about how to resolve this problem. With the alternative dispute resolution program, explained Garret, "I can take care of ten pipelines in one morning instead of spending ten days to take care of one pipeline." In addition to creating a better communication system, the program has institutionalized a way for landowners to file complaints. According to Garret:

Now these get documented to the state, which is very, very important. All these other issues that we deal with here are just between you and the company, and as long as nobody says anything out loud, they can pretty much do what they want. But these get recorded, and that is the effectiveness of it.

While Garret is currently a strong advocate of NWLA, he initially refused to become a member during the organization's early years due to its more oppositional strategy. As

mentioned in the previous profile, the organization originally approached industry more antagonistically. Garrett only joined NWLA when the leadership changed, and the organization switched to its current, more collaborative approach. As a landowner who is generally in favor of energy development, he did not want to be seen as oppositional and also acknowledged that the energy industry is not monolithic, stating, “There’s some very good companies out there.” His more nuanced views of the industry reinforce his openness to working with industry and not against it. However, he has also experienced many challenges on his farm due to impacts from energy development. His involvement with NWLA and his views about energy development suggest tension between a willingness to accommodate industry and a desire to protect landowners’ rights.

The Benefits and Risks of NWLA

The NWLA has taken on a substantial set of challenges: a commitment to pursuing policy solutions to undesired impacts of energy development without antagonizing industry, and doing so on behalf of landowner members with attitudes toward formal government that could be described as ambivalent at best. Aligning with the NWLA approach appears to offer both benefits and risks for members, including the leadership. While our interviewees acknowledged the influence of NWLA in developing mitigation strategies for unwanted impacts, these solutions were not without their costs. In this final section, we explore the tradeoffs in landowner organizing and governance solutions involving industry partnerships.

A key benefit for members is that NWLA helps to equalize power dynamics between individual landowners and energy companies. Each of the members profiled

here joined NWLA due to perceived power and knowledge imbalances between the individual landowner and the energy companies. The system, they argued, is built to keep individuals separate from each other. As Ellen noted, “[I]t’s really a business philosophy,” suggesting that industry is strategically separating community members to maximize their own benefits. The landowners felt the imbalance of knowledge is why an organization like NWLA is important. Each landowner agreed that his or her voice was amplified by NWLA, which was critical, given the individualized system in which contracts, leases, and easements are negotiated. This finding aligns with findings from the Queensland Gasfields Commission’s review, which also found that landowners felt powerless in relation to coal seam gas development.

NWLA has worked strategically to present itself as a collaborator with industry and state government agencies. Jim emphasized the need to focus on solutions and not just complaints, suggesting that NWLA’s collaborative strategy was superior to a more antagonistic approach. NWLA has focused its efforts on building its relationship with industry and government agencies. Though this process took years to achieve, NWLA members now have access to top Petroleum Council representatives, the Secretary of Agriculture, and other important political figures. The pipeline ombudsman program with its collaborative approach to solving issues between industry and landowners, is a clear outcome of this strategy.

While this strategy helps landowners, industry, and policy-makers to work together, it also exposes NWLA to the risk of being criticized as being too close to industry. An ongoing point of tension is whether or not they are enabling industry

interests at the expense of landowners' rights. If, for example, they are becoming "token mascots" of the shale industry's social license to operate. NWLA leaders must constantly balance their partnerships with industry with their ability to uphold landowner rights in order to maintain the relevance of the organization to their members.

Finally, active leadership in the development of governance solutions created a major time burden on a small group of NWLA volunteers. To create the ombudsman program, NWLA members spent countless hours in meetings with state representatives and regulators, in addition to attending hearings and testifying. Developing empathy and trust from industry and legislators took many years to achieve. The key members profiled in this chapter believe that the association's increasing success is largely due to the passion of their current leader and the enormous amount of time invested by several key volunteers. These individuals worked hard to make sure that organization was represented and present at all the "right" meetings. This model of governance has taken a personal toll on members, as shown by Jim's fatigue. In the absence of federal energy policy, NWLA members had to invest large quantities of time to organize, plan, inform, and lobby to create a better regulatory framework for North Dakota. The long-term sustainability of this model, however, is questionable.

NWLA's experiences lobbying for the alternative dispute resolution program suggest important lessons for residents in other shale plays looking to mitigate undesired impacts or create alternative dispute resolution mechanisms. Landowners may be able to achieve positive governance solutions by strategically partnering with industry. As in North Dakota, Alberta, and Queensland, industry may see these governance solutions as a

way to increase and/or maintain their social license to operate. However, landowners in other shale plays should be aware of the many hours and even years that this strategy may demand.

Conclusion

The devolved governance system in the United States has resulted in a regulatory vacuum that promotes ad hoc responses to managing socioeconomic and environmental impacts from UFF development. In North Dakota, NWLA members began organizing and lobbying for policy and regulatory change at the state level to address undesired impacts, particularly related to pipeline reclamation. Since 2009, the organization has opened up new pathways for landowners to access industry decision-makers and policy-makers, including the pipeline ombudsman program. The NWLA members profiled in this chapter shared personal stories about feeling disempowered and/or taken advantage of by the shale industry. They relied on NWLA to amplify their voices and to help them better manage impacts from energy infrastructure.

NWLA raises questions about how civic organizations can work collaboratively with industry and government to create managed shale development. The emergence of alternative dispute resolution programs in North Dakota, Alberta, and Queensland suggests a general trend toward more formalized structures for collaboration between government agencies, industry, and landowners. While alternative resolution mechanisms are reactive as opposed to proactive, they can help address power inequities that result from devolvement and deregulation. The experiences of the NWLA members profiled in this chapter point to the efficacy of partnering with industry but also vulnerabilities

associated with this model, such as how highly dependent NWLA is on a small number of individuals. For landowners in other shales plays, NWLA offers critical lessons about how devolved governance can simultaneously empower landowners while also creating uncompensated burdens.

References Cited in Chapter Four

- Alberta Energy Regulator. 2013. "Alternative Dispute Resolution Program and Guidelines for Energy Industry Disputes." Manual 004.
<http://aer.ca/documents/manuals/Manual004.pdf>.
- Alberta Energy Regulator. 2016. "2015/2016 Annual Report."
<http://www.aer.ca/documents/reports/AER2015-16AnnualReport.pdf>.
- Balliet, K. (2008). Should you join a landowner group? (p. 2). State College, PA: Penn State Extension. Retrieved from <http://extension.psu.edu/natural-resources/natural-gas/issues/leases/publications/should-you-join-a-landowner-group>
- Berg, B. L., & Lune, H. (2004). *Qualitative research methods for the social sciences*. Upper Saddle River, NJ: Pearson Education.
- Brasier, K. J., Filteau, M. R., McLaughlin, D. K. et al. (2011). Residents' perceptions of community and environmental impacts form development of natural gas in the Marcellus Shale: A comparison of Pennsylvania and New York Cases. *Journal of Rural Social Sciences*, 26(1), 32.
- Bridge, G., & Perreault, T. (2009). Environmental governance. In N. Castree, D. Demeritt, D. Liverman, & B. Rhoads (Eds.), *A companion to environmental geography* (pp. 475–497). Oxford: Blackwell.
- Haggerty, M. N., & Haggerty, J. H. (2015). Energy development as opportunity and challenge in the rural west. In D. Danbom (Ed.), *Bridging the distance*. Salt Lake City, UT: University of Utah Press.
- Harvey, D. (2005). *A brief history of neoliberalism*. Oxford: Oxford University Press.
- Jacquet, J. B., & Kay, D. L. (2014). The unconventional boomtown: Updating the impact model to fit new spatial and temporal scales. *Journal of Rural and Community Development*, 9(1), 1–23.
- Jacquet, J., & Stedman, R. C. (2011). Natural gas landowner coalitions in New York State: Emerging benefits of collective natural resource management. *Journal of Rural Social Sciences*, 26(1), 62.
- Junkert, Ken, and Dough Goehring. 2016. "Pipeline Restoration and Reclamation Oversight Pilot Program." North Dakota Department of Agriculture.
- Klassen, J. A., & Feldpausch-Parker, A. M. (2011). Oiling the gears of public participation: the value of organizations in establishing Trinity of Voice for

- communities impacted by the oil and gas industry. *Local Environment*, 16(9), 903–915.
- Konschnik, K. E., & Boling, M. K. (2014). Shale gas development: A smart regulation framework. *Environmental Science & Technology*, 48(15), 8404–8416.
- Moffat, Kieren, and Airong Zhang. 2014. “The Paths to Social License to Operate: An Integrative Model Explaining Community Acceptance of Mining.” *Resources Policy* 39: 61–70.
- Murphy, Kieran. 2017. “Queensland Gas Industry Welcomes Moves to Establish Land Access Ombudsman.” *Australian Petroleum Production & Exploration Association*, May 24, 2017.
https://www.appea.com.au/media_release/queensland-gas-industry-welcomes-moves-to-establish-land-access-ombudsman.
- Levi-Faur, D. (2005). The global diffusion of regulatory capitalism. *The Annals of the American Academy of Political and Social Science*, 598(1), 12–32.
- Lindlof, T. R. (1995). *Qualitative communication research methods* (Vol. 3). Thousand Oaks, CA: Sage Publications.
- Scott, Robert P. 2016. “Independent Review of the Gasfields Commission Queensland and Associated Matters.” State of Queensland, Department of State Development.
<https://www.statedevelopment.qld.gov.au/resources/report/gasfields-commission-review-report.pdf>.
- Small, M. J., Stern, P. C., Bomberg, E., et al. (2014). Risks and risk governance in unconventional shale gas development. *Environmental Science & Technology*, 48(15), 8289–8297.
- Warner, B., & Shapiro, J. (2013). Fractured, fragmented federalism: A study in fracking regulatory policy. *Publius: The Journal of Federalism*, 43(3), 474–496.
- Whitton, John, Kathryn J. Brasier, Ioan Charnley-Parry, and Matthew Cotton. 2017. “Shale Gas Governance in the United Kingdom and the United States: Opportunities for Public Participation and the Implications for Social Justice.” *Energy Research & Social Science* 26: 11–22.
- Ziorgiannis, Nikolaos, Jessica Alcorn, John Rupp, Sanya Carley, and John D. Graham. 2016. “State Regulation of Unconventional Gas Development in the US: An Empirical Evaluation.” *Energy Research & Social Science* 11: 142–54.

CHAPTER FIVE

USING SHARED SERVICES TO MITIGATE BOOMTOWN IMPACTS IN THE
BAKKEN SHALE PLAY: RESOURCEFULNESS OR OVER-ADAPTATION?

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Introduction

Energy boomtowns often exemplify local governments in crisis. During the Bakken boom in unconventional oil and gas (UOG) development the population of Watford City, North Dakota, increased over 300 percent. From 2000 to 2016, an estimated 4,300 residents and an unknown number of temporary oilfield workers flocked to this small county seat that previously had fewer than 1,500 residents. The influx stressed the city's infrastructure and services beyond capacity. Consultants estimated that Watford City needed over \$193.6 million in 2012 in upgrades to its water, wastewater, and road infrastructure to meet service demand and accommodate the rapid growth (Vision West ND, 2012). The magnitude of the needs for this one city greatly exceeded available financial resources. For reference, the entire county's budget that year was just \$53.4 million. Watford City's experience exemplifies familiar dilemmas in the boomtown impacts literature, particularly in rural regions like the Bakken (Gilmore, 1976; Gulliford, 1989).

Despite the obvious practical need for local government strategies to mitigate service impacts, the shared services and energy impacts scholarship have proceeded in isolation from one another. Previous research suggests that times of crisis can be leveraged into moments where new inter- and intra-government collaborations and shared services are possible (Alexander, 1995; Bryson, Crosby, & Stone, 2006; Kim, 2018). These arrangements may offer strategies for mitigating boom impacts. This article works to bridge the gap between the shared services and boomtown literatures by analyzing four examples of municipal development projects that reimagine service provision and

production in two key hubs for the Bakken oil boom, Williston and Watford City, North Dakota. Whereas most research on shared services focuses on communities reacting to fiscal stress and/or declining populations, this case study expands the shared services literature into new geographies—specifically, the remote and rural boomtown.

The Bakken shale play has received relatively less academic research attention when compared to other regions that host unconventional oil and gas development, such as the Marcellus shale play (Walsh & Haggerty, 2019). Yet, the boom's impacts on services and infrastructure in the Bakken have been dramatic due to its relative remoteness and low population densities (Fernando & Cooley, 2016b; Haggerty, Kroepsch, Walsh, Smith, & Bowen, 2018b). This research therefore seeks to make three contributions to the scholarship at the nexus of the boomtown and shared services literatures: (1) To document how local governments mitigated impacts to their services in the Bakken shale play, (2) to draw connections between the boomtown and shared services literature with the goal of addressing gaps in both, and (3) to critique the use of shared services in the context of the rural, remote boomtown. The article begins with an overview of the shared services and boomtown literatures, followed by a description of the case study methods. Next, it offers an analysis of how local governments used shared services as solutions to short-term boom impacts and also as longer-term strategies to promote quality of life. It ends with a critique of these strategies and calls for future research into the use of shared services as a strategy for addressing rural boomtown impacts.

The Shared Services and Rural Boomtown Nexus

Shared Services

The term shared services describes collaborations between a government entity and at least one or more other entities (government, non-profit, community organization, and/or private company) in the act of local government service production and/or provision (Morse & Abernathy, 2015). These strategies have become increasingly popular for rethinking service provision approaches (Blair & Janousek, 2013; Warner, 2017), particularly during times of crisis—an economic recession, policy change, or service disruption (Alexander, 1995; Bryson, Crosby, & Stone, 2006). Much of the existing literature has been motivated by the potential for service sharing to create economic efficiencies, typically in response to fiscal stress (Bel & Warner, 2015, 2016; Jimenez & Hendrick, 2010; Raudla & Tavares, 2018).

Types of shared services range from informal ‘handshake’ agreements to formal contracts between and within governments (Benton, 2013; Blair & Janousek, 2013). The majority of research on shared services has focused on contracting out services to public or private entities (Bel & Warner, 2016; Morse & Abernathy, 2015). However, shared services take many forms. Examples include sharing personnel or equipment between governments and/or community organizations, co-locating departments in a common facility, creating services with joint operations between city and county governments, and consolidating departments into new joint entities, such as a fire tax district. Most shared services are negotiated de novo rather than from boilerplate and are thus tailored to

address the local context and available resources (Hilvert & Swindell, 2013; Kim & Warner, 2016).

For rural regions, local governments' motivations for implementing shared services are often pragmatic. Rural governments face challenges with service production and provisioning due to limited capacities, higher costs stemming from low population densities and expansive coverage regions, and imperfect markets with limited competition (Brown & Schafft, 2011; Warner, 2006). Due to this "social cost of space" (Kraenzel, 1955, p. 201), shared service arrangements can allow governments to reorganize their services while avoiding politically unpopular decisions, such as full consolidation or dissolutions. Importantly, Delabbio and Zeemering (2013) highlight that not all governments are equally poised to implement shared services; local governments' abilities to collaborate with other entities are dependent on the community's institutional context, leadership capacity, and decision makers' comfort with risk, amongst other factors.

The shared services scholarship is often embedded within broader questions of the impacts of neoliberalism, austerity politics, and/or local government fragmentation. Studies have attributed the surge in shared service arrangements to a range of factors: devolved governance and/or decreased federal and state budgets (Bel, Hebdon, & Warner, 2018; Warner & Hefetz, 2009), political pressure for increased government efficiency and smaller governments (Benton, 2013; Delabbio & Zeemering, 2013), and fiscal stress stemming from recessions (Kim, 2018; Kim & Warner, 2016). Local governments may establish shared services to save money while maintaining or

increasing service levels, improve decision-making capabilities, and/or strengthen their accountability to taxpayers (Benton, 2013; Zeemering & Delabbio, 2013). Shared services can also help unite previously disparate governing entities (Brenner, 2002) and strengthen social capital, such as by building trust or creating new possibilities for future collaboration through increased contact with co-workers (Morse & Abernathy, 2015; Linden, 2010).

While there is a general assumption that consolidation of services will allow local governments to capture economies of scale, emerging research complicates this belief (cf. Bel & Warner, 2016). In a longitudinal study of New York counties, Kay and Corrigan (2018) found that inter-municipal sharing did not lead to statistically significant cost savings in local governments, though they noted the collaborations may have resulted in other benefits beyond fiscal measurements. In a study of California cities that terminated interlocal contracts, Zeemering (2017) found that the contracts were ended due to a perceived lack of local budget control, poor service levels, inadequate contract management, and insufficient community relationship management. Other challenges with inter-municipal cooperation include difficulties in monitoring partners, partner selection processes, declining service quality, and the complexity of regional coordination (Warner, 2017). To date, the shared services literature has largely ignored energy boom impacts to public services.

Energy Development Impacts on Services and Infrastructure

Beginning in the 1970s, in response to booms in industrial energy development, interest in studying boomtown effects soared (Smith, Krannich, & Hunter, 2001). These

studies coalesced to form the social disruption model (also called the boomtown model) that described energy booms as “a mix of positive and negative economic impacts to local residents, contrasted with highly negative social impacts” (Jacquet, 2009, p. 8). Researchers attributed many of the boom’s negative impacts, including degradations to quality of life, to the inability of local governments to manage skyrocketing demands on public services and infrastructure (e.g., Gilmore, 1976; Kohrs, 1974). The ‘Shale Revolution’ of the 2000s renewed research interest in analyzing the social impacts of energy development, with many researchers again noting the importance of addressing impacts to services and infrastructure (e.g., Jacquet & Kay, 2014; Measham, Fleming, & Schandl, 2016; Ruddell, 2017).

In the United States, the nature of UOG development in rural regions poses specific problems for public service production and provisioning. Due to the sprawling footprint of UOG development, a large labor force is needed to facilitate the boom. For rural geographies, this requires a massive in-migration of workers and a predictable set of impacts: housing shortages, traffic jams, rising labor and construction costs, and increased demands on water and wastewater systems, emergency services, schools, and hospitals (Haggerty et al., 2018b). While local governments will likely benefit financially from the boom due to increases in tax revenues and/or royalty or leasing payments, their expanded budgets are not always sufficient to cover costs for new and/or upgraded infrastructure and services (Newell & Raimi, 2018).

Rural regions are particularly vulnerable to boom and bust cycles due to their economic structure, the volatility of the oil industry, and the impacts of devolved

governance (Haggerty et al., 2018b). Changes in global oil prices, for example, result in massive, unpredictable swings in oil activity at the local level. The corresponding increases and decreases in tax revenues and service demands create a challenging, hard-to-predict context for local government planning (Christopherson & Rightor, 2012; Keough 2015). The rapid pace of UOG development exacerbates challenges for successfully mitigating unwanted impacts and capturing potential benefits (Measham et al., 2016). Subsequently, local governments often address UOG impacts reactively as opposed to planning proactively for economic diversification, creating a risk of entrenching natural resource dependence (Freudenberg, 1992). Further, due to the devolvement of economic and community development responsibilities, local governments are forced to respond to the boom's rapid, cascading changes in service demand on their own—a steep task for any community (Haggerty, Smith, Mastel, Lapan, & Lachapelle, 2018c; Smith & Haggerty, 2018).

The Bakken Shale Play

The Bakken shale play has received less academic research attention than other shale plays (Walsh & Haggerty, 2019), despite the Bakken exemplifying the typical remote and rural boomtowns of the American West (Haggerty et al., 2018b). What social impacts research exists predominantly focuses on the social disruptions prompted by the Bakken boom, including increased crime and pressures on emergency service personnel (Dahle & Archbold, 2015; Ruddell, 2017), impacts on quality of life and how impacts vary by stakeholder group (Fernando & Cooley 2016a), and how the boom has shifted attitudes and/or perceptions towards UOG development (Fernando & Cooley, 2016b;

Loder, 2016; McEvoy, Gilbertz, Anderson, Ormerod, & Bergmann 2017). Other research has focused on the fiscal challenges of the boom, including increasing debt loads from service and infrastructure investments (Newell & Raimi, 2018), as well as strategies that various stakeholders have taken to address negative impacts and leverage benefits (Haggerty et al, 2018c; Smith & Haggerty, 2018). Due to the extremity of the boom's impacts, both positive and negative, the region has attracted immense media attention, much of which focuses on the drama of the boom as opposed to offering nuanced analyses of how the boom has changed the region in the short- and long-term (Becker 2016; Rao, 2018).

Notably, the shared services scholarship has largely overlooked rural boomtowns, including those within the Bakken, with the exception of Hultquist, Harsell, Wood, and Flynn's (2017) research on the use of local government contracting in North Dakota. This study found that communities with higher oil and gas employment were more likely to provide services in-house than other communities with rapid growth. The authors hypothesized the finding was due to increases in revenues from UOG, rising costs of contract labor, and/or community leaders' beliefs that energy development would persist long-term, justifying in-house service production. Their research highlights the intersection of the boomtown and shared services literatures as a fruitful area of research. However, the authors stopped short of asking how the boom may prompt shared services and/or how shared services could be employed as a strategy to mitigate against undesired boomtown impacts. The interaction between rurality and boomtown dynamics shapes opportunities for shared services in ways that have not yet been studied.

MethodsCase Study Site: The Bakken Shale
Play in Western North Dakota

From the mid-2000s to 2014, oil extraction from Bakken shale created a boom in UOG development in eastern Montana and western North Dakota (Haggerty et al, 2018b). The majority of UOG development occurred in four North Dakota counties: McKenzie, Mountrail, Dunn, and Williams. This case study focuses on two of the primary service hubs for the oil industry that experienced extensive boom impacts: Watford City (McKenzie County) and Williston (Williams County). Both McKenzie and Williams Counties experienced either stagnant or declining population growth for 25 years prior to the boom. When the boom began, Williston and Watford City experienced dramatic population growth. In response, local governments instigated efforts to expand their infrastructure and facilities as they struggled to meet demands on their public services. This study investigates four development projects that were built during the boom, as summarized in Table 5.1. Collectively, they illustrate a host of collaborative strategies that local government leaders and/or community organizations pursued to mitigate boom impacts.

Table 5.1. Shared service projects built in Williston and Watford City during boom.

Williston State College Foundation Apartments & DMV | Cost: \$8.5 million | Completed: 2013

This 74-unit affordable housing complex was constructed for Williston State College staff and community essential services employees. The building serves as a joint facility that houses the Williston Motor Vehicle Office.

Wolf Run Village, Watford City | Cost: \$6 million | Completed: 2013

The county, city, and school district collaborated to establish a 501(c)(3) nonprofit organization to build a 42-unit affordable housing complex for teachers and essential services employees. The project also included a daycare.

Williston Area Recreation Center (ARC) | Cost: \$76 million | Completed: 2014

Similar to the Rough Rider Center (RRC), this is one of the largest municipally-owned recreation centers in the United States at 254,000 sq. ft. It was built on Williston State College land with significant resource sharing between the city and the college.

Rough Rider Center (RRC), Watford City | Cost: \$92 million | Completed: 2016

At 268,000 sq. ft., this is one of the largest municipally-owned recreation centers in the United States. The Parks Board runs the RRC with significant resource sharing of employees and equipment between the local high school and other community organizations.

Data Collection and Analysis

The case study draws upon in-person interviews with 19 community leaders, including economic development professionals, local government representatives, and local and state government employees. The interviews occurred as part of a larger data collection effort during the summers of 2016 and 2017, a period of slowdown in oil and gas activity. Whereas existing scholarship tends to focus on the boom phase, the timing of this study helps address the gap in research on long-term impacts, as noted by Krannich (2017). Watford City and Williston were chosen as the research sites due to the

extensive oil production within their vicinity and their roles as major service hubs for the oil industry.

The authors created the sample pool of interviewees by compiling a list of community leaders for McKenzie and Williams Counties and recruiting participants through email and phone calls. Nearly all contacted individuals agreed to be interviewed, and those who did not cited the heavy workloads that persisted post-boom. Interviews were in-depth, semi-structured, and conducted in person. The shortest interview lasted 39 minutes, the longest lasted 131 minutes, and the average lasted 75 minutes. The interviews were recorded and then transcribed verbatim. The digital files were uploaded into Nvivo for coding and analysis.

During coding, the interviews were analyzed to understand the motivations community leaders revealed about their choices to implement shared services and the challenges they encountered. Codes were collapsed and expanded throughout the analysis process, which involved multiple readings, as well as comparisons and contrasts with findings from previous research (Charmaz, 2005; Lindlof & Taylor, 2011).

The projects were chosen based on input from the interviewees and the researchers' participant observations. The research began with an interest in economic development strategies. When the use of shared services arose as a recurring theme, the interviews shifted to explore shared services as a mitigation strategy for boom impacts. Community leaders identified these projects as examples of how their community reacted to the boom. The projects were extensively researched upon selection. Supplemental documents were collected and analyzed to triangulate findings, including news articles, testimony

from the state legislature, and relevant board meeting minutes. The projects are not a comprehensive list of shared services within the region but rather examples of how two communities responded to perceived opportunities and/or needs prompted by the boom.

Findings: Shared Services and the Boom

The Bakken boom sparked new forms of shared services and institutional arrangements, albeit with different temporal, spatial, and economic dimensions. The first two projects highlighted in this case study represent solutions designed to mitigate against undesired but temporary boom impacts. The other two projects are larger investments designed to leverage the boom into longer-term quality of life improvements. Each project demonstrates attempts by local leaders to proactively engage with an unpredictable commodity cycle. This resourcefulness has roots in community leaders' previous experiences with boom and bust economies. Many of the interview participants remembered the depopulation, economic decline, and burden of large municipal debts that occurred after the 1980s oil boom. Community leaders repeatedly emphasized the need to extend savings to taxpayers and create efficiencies in service provision. As one leader explained with regards to government spending in the context of the boom, "I think people in northwest North Dakota have been and tried to be resourceful." This awareness and engagement with the boom-bust cycle align with recent boomtown findings that North Dakotans have "an attitude of wariness that pervades" with regards to community and economic development investments (Becker, 2016, p. 20). Given this awareness, community leaders created shared service strategies to address boom impacts with fiscal conservatism, though this goal was not always achieved.

As previous shared services research illustrates, the logistics of creating and maintaining partnerships are often complicated and time-intensive (e.g., Carr & Hawkins, 2013; Hefetz, Warner, & Vigoda-Gadot, 2012). When community leaders in Williston and Watford City were asked about the challenges of forming partnerships, many responded by emphasizing how much time they spent in community and organizational meetings. This case study focuses on the more unique challenges of creating shared services during an oil boom, but the time investment that the projects represent should not be underestimated. The following analysis describes how each project was created, the motivations for incorporating shared services, and the challenges encountered.

Shared Services as Mitigation Strategies to Temporary Boom Impacts

The shared services projects highlighted in this article are notable for their rapid formation and construction, reflective of the heightened pace of UOG development. The tremendous levels of in-migration associated with the build-up and boom phases of UOG development stressed local communities (Headwaters Economics, 2012) and, at times, forced on-the-fly decision making. The Williston State College Foundation's contract with the DMV and the Wolf Run Village in Watford City are both shared services that were created to address distinct boom impacts: the risk of the DMV closing in Williston and the lack of affordable housing and daycare in Watford City. Both projects were built during the height of the boom when impacts to services were the most acute.

Williston State College Foundation apartments and the DMV. The immediacy of the boom prompted unexpected collaborations. In response to housing shortages in Williston, the Williston State College Foundation assumed responsibility for building and

managing an affordable housing complex, an atypical role for a college foundation. Even more surprising, the Foundation took over the management of the Williston Motor Vehicle Office when the North Dakota Department of Transportation (NDDOT) was unable to find another entity to run it. The Foundation built an office for the DMV in its affordable housing complex and managed its operations from 2011 to 2018.

The impetus behind the Foundation's decision to run the DMV offers important insights into how devolved governance compounds the impacts from UOG development. While many states have a singular DMV, North Dakota has two separate departments: the Driver's License Division and the Motor Vehicle Division (referred to in this article by its more common name, the DMV). While the Driver's License Division is run by the state, most of the Motor Vehicle Division offices are run by third-party operators, such as chamber of commerce branches, county offices, and private operators. Prior to the Bakken boom, the Williston Area Chamber of Commerce ran the DMV. In 2011, as UOG development intensified, the chamber decided to end its contract (Killelea, 2013), as it was not able to keep up with the spike in demand on its services. As an interviewee explained, "The chamber at the time had one or two employees. Then the boom hit. The lines were out into the street of people wanting to get titles, license renewals." No other entity was interested in running the DMV because of the challenges imposed by the boom, both the high demand on the office's services and the problem of finding employees given labor shortages.

The Williston State College Foundation agreed to run the DMV as an ad-hoc solution to an immediate need to keep it operating. One stakeholder involved with the project explained the origins of this shared service:

So, we had a local legislator that I know quite well, and he called me and said, ‘Do you think there’s any way...the Foundation could house or manage the DMV while we’re in this insane environment?’... So basically we worked with the state, Department of Transportation, our local legislators, and the college... we did it. The Foundation managed it. We housed in on the college campus, and we hired employees...

The shared service was enabled by the region’s tight-knit social networks, in which a local legislator and a Foundation representative could begin to problem solve a boom impact via a phone call. This partnership also illustrates how devolved governance exacerbates boomtown problems. While third parties may be willing to run the DMV under normal circumstances, the boom decreased incentives for third-party operators. The NDDOT bid the DMV’s management out multiple times but received no offers. Thus, the unexpected partnership between the Foundation and the DMV was due to the regulatory void created by North Dakota’s outsourcing and privatization of its Motor Vehicle Division.

Importantly, the Foundation’s management of the DMV was intentionally designed as a short-term contract. The DMV did not align with the Foundation’s goals. As one organizer quipped, “None of us, including myself or the foundation board, really felt this was part of our mission.” From the initiation of the shared services arrangement, the Foundation planned to end its management of the DMV by 2019. In 2018, the NDDOT again attempted to bid out the franchise to private industry and again did not receive any offers (Williston Board of City Commissioners, 2018). In response, Williams

County agreed to take over the DMV's management. In the short-term, the DMV will continue to be housed in the Foundation's apartment building but is now run by the county government, creating a new iteration of the shared services arrangement. The partnership illustrates the potential for a boom to instigate unexpected but effective governance strategies to address impacts to services.

Wolf Run Village, Watford City. Community leaders' use of shared services transcended traditional department boundaries within local governments. The Wolf Run Village, an affordable housing complex in Watford City, demonstrates how the compounding impacts from the boom resulted in collaborative projects between different government sub-divisions. Researchers have noted that multi-organization, networked approaches like the Wolf Run Village can be effective strategies for addressing governance challenges in UOG boomtowns (Wilson, Morrison, Everingham, & McCarthy, 2017).

The Wolf Run Village was built as a solution to the housing and childcare shortages created by the boom. In Watford City, school enrollment increased 20-25% annually beginning in 2011. The school district needed more teachers and staff, but administrators struggled with recruitment. Prospective employees were skeptical of the city due to negative media portrayals of the boom, and there was a lack of affordable housing. The school district attempted to address the housing shortage by providing teachers with on-site trailers located next to the playground, but the living situation was not considered ideal. Meanwhile, city and county departments were experiencing similar challenges when recruiting government employees.

In response to perceived community needs, the city of Watford City, the school district, and the McKenzie County government collectively conducted a community assessment in 2011, and affordable housing and daycare emerged as priorities. The three entities then formed a new 501(c)(3) nonprofit organization to collaborate on building and managing the Wolf Run Village, an affordable housing complex for teachers and essential services staff that included an on-site daycare. The newly-formed joint organization was an important aspect of this project as it allowed the group to raise private funds and apply for state funding available to nonprofit organizations. The organization coordinated multiple entities who shared common needs and resulted in housing that could be used as an employee recruitment tool.

Similar to the DMV project, this collaboration was enabled by the tight-knit social structure of the small community. One interviewee explained that a core group of city, county, and school board representatives regularly met and communicated through formal community meetings and informally through social events. Additionally, stakeholders regularly described the city's leaders as "proactive" and "progressive," with the implication that their community has strong leadership capacity. They proudly noted that the city's former mayor, Brent Sanford, is now the Lieutenant Governor of North Dakota. Watford City residents' abilities to establish partnerships and leverage local resources have been celebrated by other researchers, such as by Flora and Flora (2016) in their seminal chapter on social capital. While the willingness for city, county, and school district representatives to work together is not unique to Watford City, the extent to which they collaborate is notable. This same group of leaders was also responsible for the

formation of the Rough Rider Center's shared services, as will be discussed in the next section.

As the immediate impacts from the boom declined, community leaders' vision for the Wolf Run Village shifted. Initially, community leaders argued that public involvement in the housing and childcare sectors was necessary because the private sector was not sufficiently addressing regional needs. When interviewed in 2017, leaders noted that the private sector had caught up, at least with regards to housing availability. This led some leaders to rethink the government's involvement with the Wolf Run Village. As one leader explained, "Probably in the next couple years, easily, all three entities will no longer be in the housing game. We'll hand that back over to the private. People can get reasonable rent? Great! Served its purpose." Given the volatility of the UOG development, the willingness to end a shared service is potentially as important as the willingness to start a collaboration. Whether or not community leaders will actually be able to end their involvement by finding an interested buyer, however, is uncertain.

Although shared services have the potential to offer solutions to boom impacts, the volatility of oil development remains a substantial challenge to their long-term viability. On the one hand, the Wolf Run Village is an example of a shared service in which community leaders successfully reimagined their institutions to create a new approach to providing affordable housing and child care resources. However, the downturn in oil development that began in 2015 created financial problems for the apartment complex. As of 2017, the project was losing \$30,000 – \$50,000 per month and the county had to offer financial assistance to assist with debt payments (Shipman, 2018).

This project exemplifies the distinctive challenges for creating shared services, particularly in the ongoing maintenance of the projects during slowdowns and busts. There is a substantial risk that communities will build projects that may become obsolete when development declines and/or lead to unsustainable debt loads. Even when local governments are willing to continually reimagine their services, the volatility of global markets may create constraints that are unsurmountable.

Shared Services as Long-term Development Strategies

The Williston Area Recreation Center (ARC) and the Rough Rider Center (RRC) in Watford City offer examples of local governments using shared services as long-term community and economic development strategies. In Williston, a quality of life committee helped plan the ARC, which was seen as “really a big piece of quality of life for people that moved here—a place to take your family...” A similar process played out in the development of Watford City’s RRC. A community leader noted that “we did a lot of community assessment... if we don’t want to be a community where people blow in here and work for two weeks and then blow back to Denver, then what is it that make people want to live here?” Community leaders felt increasing local amenities and recreation facilities would support economic diversification. Similar strategies have been used in other communities with intensive energy development, such as Fort St. John, British Columbia (Markey, Halseth, Ryser, Argent, & Boron, 2019). These planning efforts emphasized quality of life with the subtext—at times implicit and at other times explicit—of attracting industry and retaining residents who had migrated to the region.

However, they also tended towards the extravagant, creating a risk of increased municipal gross debt.

Williston Area Recreation Center (ARC). The Williston Area Recreation Center (the ARC) is the largest park district-owned recreation center in the United States (JLG Architects, n.d.). The ARC is located on land owned by the North Dakota Board of Higher Education, and its operations rely on extensive resource sharing between the Williston Parks and Recreation District (referred to hereafter as the Parks District) and Williston State College. The partnership was a result of the skyrocketing land prices in Williston, prompted by the boom, that made building a new recreation center prohibitively expensive for the city. As a solution, the College leased five acres of its land to the Parks District for \$1 for 99 years and committed to paying an annual fee. In return, the College's students have access to the facilities and the College's employees and administration can use the public meeting rooms. The project involves ongoing negotiations between the entities. A Williston State College employee explained that the project's "...shared space, shared service, shared staff, shared equipment has kind of just evolved over time. And it keeps getting refined over time." This speaks to the Parks District's continuing reorganization of their services and to the constant innovation that the boom prompted within local governments.

The ARC demonstrates how the unique context of a UOG boom shapes shared service projects. Oil and gas development is exempt from property taxes in North Dakota, meaning that local governments' budgets primarily benefit from state allocations of severance taxes and upticks in sales tax revenues (Newell & Raimi, 2015). As UOG

development surged, the Parks District decided to capitalize on the boom's increased economic activity by switching its funding source from a property tax, which saw only constrained growth due to UOG development's tax exemption, to a more lucrative sales tax. As argued by one Parks District employee, "The guy living at the hotel is not paying property tax, but he's still using the parks. So why is he not helping pay for things?" The downside of the switch, however, is that the fluctuations of UOG development result in highly unpredictable tax revenues (Raimi & Newell, 2016), as reflected in the Parks District's budget. Before the boom, the Parks District had an annual budget of roughly \$1.9 million. In 2014, after the Parks District switched to being funded by a sales tax, its budget increased to \$14.8 million, only to drop by 39.8% to \$8.9 million in 2016. The ARC's reliance on a sales tax to repay its bonds introduced volatility into the project, a concern that would be less worrisome in communities with more predictable annual revenues.

While the ARC was designed to be a long-term investment in the community, it speaks to the risk of forming shared services in the boom context. The Parks District's original plan was to build a \$36 million facility, but as its budget ballooned the board expanded the plan: "We got this funding, what do you want to do? We want to get bigger...the original design didn't have a 50M pool in it, Olympic sized pool, didn't have a track in it, only three basketball courts, turf was not involved..." Since the Parks District had surplus revenues, the ARC was scaled up and would eventually cost \$76 million. As the UOG development slowed and sales revenues plummeted, repaying the bond became challenging. The project's costs contributed to the city's growing debt,

which was estimated at over \$225 million as of September 2017 (Haffner, 2017). The ARC has been widely popular with community members. However, the use of shared services increased its size and costs, which directly contradicts the motivation that many community leaders describe for using shared services – to increase resourcefulness and fiscal efficiency.

The Rough Rider Center (RRC), Watford City. The Rough Rider Center (RRC) is a massive 268,000 square foot recreation and conference center that was built next to the new Watford City High School and includes athletic facilities originally proposed for the school. It represents a joint powers agreement between the City of Watford City, McKenzie County School District #1, and Watford City Parks and Recreation District. The project began as a discussion between the former mayor of Watford City, the city administrator, and the school superintendent. The city administrator recruited the Parks Board to manage the center's operations, and then the Parks Board collaborated with the city on the financing. When asked how the project originated, a community leader emphasized the importance of "open dialogue, letting other people know what the needs are out there" and then noted, "We all know each other. We all kind of travel in some of the same circles." Again, Watford City's tight social network proved to be an important enabler for this project.

The RRC is a unique shared service because it was designed as a workaround solution to help fund a new high school building that otherwise would have cost too much per student to be financed (Lee, 2016). According to school officials, the funding mismatch was due to a lag in population estimates. While the city's actual population

may have been large enough to justify the school's projected costs, the outdated 'official' population statistics limited the amount community leaders could borrow. The failure of data to keep up with the boom's population growth was a commonly cited challenge for decision-makers and planners and has been noted elsewhere in the boomtown literature (e.g., Keough 2015). Community leaders proposed the RRC as a way to leverage additional funding sources—including loans backed by property and sales taxes and a distribution of the state's oil and gas taxes (Lee, 2016). Since the high school did not have the financing to build its own recreation facilities (e.g., football, baseball, and soccer fields), it was able to use the RRC's funding to fulfill and expand upon its original plan. Similar to the ARC, however, the use of a sales tax proved to be a volatile funding mechanism. One interviewee explained, when the RRC was first proposed, "the gross production tax that the city was getting well covered the payments on the building." However, by 2017 the RRC had an \$800,000 annual shortfall due to unanticipated decreases in revenues. A news article published in 2016 remarked that the RRC needed \$200,000/month in sales tax revenues to cover bond expenses, but the city only brought in \$112,321 in April of that year (Lee, 2016).

The RRC's financial troubles are related to its immense scale. Typically, governments that implement shared services in non-boom contexts must make hard compromises to ensure projects are in line with future budget projections. In contrast, UOG development in Watford City promised new sources of tax revenues and hard compromises were seemingly not made. One community leader described how their collaborations with community organizations led to the RRC's massive size:

In their planning, when they had talked to all these groups and what they wanted and everything else, that's kind of how it came about. Well, we need two sheets of ice. We need a fieldhouse or a big open space. We need an arena. Want the indoor pool. And the convention space. So they [the architects] started figuring, putting everything together – and voila!”

Notably, the RRC's collaboration with these community organizations unified their capital campaign projects and prevented them from competing against each other for donations. However, their participation also prompted the community to build an even larger complex, indicative of a lack of compromise during the planning phases.

Additionally, the dire need for a new high school to accommodate the growing population forced an accelerated schedule on the high school and the RRC building projects. As one county employee explained, “Most of the changes in the community take years and years of planning, but this was just such a boom that all these new things happened.” He went on to say that with regards to the RRC they are still waiting “for the community to catch up and catch the vision.” The lack of a vision could help explain why the Center is underutilized. Under normal circumstances, government leaders—presumably with input from the community—would decide the facility's role before construction. Instead, the Parks Board was forced to adopt an “if you build it, they will come” strategy. As one interviewee described, this has been an ongoing challenge:

There's been a lot of growing pains. I mean it hasn't been an easy transition, you know. As you can see in the middle of an afternoon, we're the only two here. There's a few playing basketball... That's the other thing that we're... trying to figure out right now is really what do people want? What do you want us to offer?

The RRC helped to fund the high school, allowed collaboration between various community and government entities, and represented an investment in the community's long-term economic development. However, the project's gargantuan size prompts

questions about whether it is a ‘white elephant project.’ Local leaders’ ongoing struggles to define the RRC’s purpose and its financial troubles raise questions about the viability of using shared services for long-term projects in the boom context.

Discussion

UOG booms in rural and remote geographies offer unique opportunities and challenges with regards to government planning for services. While many rural communities with manufacturing economies are experiencing steady population decline and shrinking tax bases, energy boomtowns often have the opposite problem during the beginning of the boom: large influxes of workers stress government services and infrastructure beyond capacity (Measham et al., 2016). These increased demands on local governments combined with large increases in tax revenues lead to rippling booms in infrastructure development and service expansion. However, sharp downturns in UOG development can trigger de-population, increasing the risk that the community will overbuild infrastructure and/or over-expand services. One strategy used in declining rural communities—shared service arrangements—may also be beneficial for energy boomtowns.

This research sought to address gaps in both the boomtown and shared services literatures, while documenting how local governments in two cities in the Bakken mitigated stresses to their services. Prior research suggests that shared services are often implemented to capture cost savings, capitalize on economies of scales, and maintain service levels (Kim & Warner, 2016). Other motivations include improving service quality (Bel & Warner, 2016) and/or appeasing calls for smaller governments (Benton,

2013; Zeemering & Delabbio, 2013). These motivations were also apparent within the shared services projects implemented in the context of a UOG boom. For example, the RRC allowed multiple organizations to be housed in one building as opposed to each fundraising and constructing their own facilities. Similarly, the Williston State College Foundation's takeover of the DMV allowed its operations to continue when no other entity wanted to run it. In this light, the shared services projects in the Bakken echoed those found in other communities.

However, the shared services projects that occurred in the Bakken also reflect a unique set of circumstances that serve to expand the shared services literature. As Delabbio and Zeemering (2013) argue, the local context is important for understanding the successes and failures of shared services. UOG booms in remote geographies offer short-term economic benefits and a host of short- to long-term challenges, ranging from increased traffic to economic overspecialization on a volatile commodity (Haggerty et al., 2018b). Many of these impacts are more intense during the beginning phases of the boom. Remote boomtowns face hard-to-predict and extreme swings in service demand that create an ambiguous planning space and revenue outlook (Keough 2015). Much of the previous literature on boomtowns paints local governments as overwhelmed by energy impacts or at best passive.

In this context, we offer the following readings of the findings. On the one hand, the boom prompted an immense amount of innovation at the local level, demonstrated here by community leaders' use of a wide variety of shared services. This observation challenges existing depictions of rural energy boomtowns as overwhelmed and passive. A

narrative of rural innovation and local agency in response to energy impacts is often ignored within boomtown and social disruption research, though it has been noted in the shared services literature (e.g., Hilvert & Swindell, 2013). In the cases reported here, rural energy boomtowns in the Bakken responded effectively to the rapid pace and scale of impacts by filling service gaps and uniting services that were previously fragmented. The end results ranged in contract length, the amount of complexity involved, and level of shared governance. Nonetheless, all of the projects speak to a high level of inventiveness as leaders worked to address boomtown impacts.

On the other hand, shared services at times allowed for community projects to expand to the point of aggravating the risk of exposure to volatile service demand and revenue streams. In this way, their role in the success of local governments in responding to energy impacts was mixed. This was particularly true for the larger and longer-term shared services projects in this case study. Despite their marked innovation, the projects described here suggest a tendency towards the extravagant. Whereas shared services are often employed to minimize costs, the use of shared services in the Bakken increased debt obligations. The ARC and the RRC are two of the largest municipally-owned recreation facilities in the United States, though they serve relatively small population centers. Both centers struggled to make loan payments during slowdowns in UOG development.

Here is the other dimension of an energy boom, particularly one as large in magnitude as the Bakken—the problem of forecasting service demands in the context of uncertain and/or unreliable estimates of future population change. Shared services that

were created as solutions to temporary boom impacts suggest the nimbleness with which local governments can plan despite the uncertainty. The Foundation's management of the DMV was an unorthodox but practical governance solution to the DMV's pending closure. In contrast, the RRC and the ARC were financially larger and longer-term investments. Rather than mitigating against the effects of declines in population and economic activity, the shared services worked to exacerbate their exposure to decline. These projects reinforced the tendency of many community leaders to be overly optimistic about the duration and long-term benefits of the boom.

These projects hold important lessons for local governments and decision makers. First, when compared to the shared service projects that address temporary impacts, the RRC and the ARC are better poised to create long-term benefits for the two cities. However, they are also riskier. This reinforces a fundamental tension for communities that host natural resource extraction: while community leaders may desire economic diversification, their ability to actually achieve this goal is constrained (Freudenburg, 1992). Second, community leaders must take into account the high degree of uncertainty regarding different outcomes (or the timing of different outcomes) of oil development. As shown by Haggerty et al. (2018a), many community members believe that the boom will last longer than it actually does. While the boom-bust cycle was acknowledged in interviews, community leaders still tended to gravitate towards the grandiose and were willing to finance projects through revenues streams that were dependent on UOG development levels. Third, in the context of a boom, employing shared services as an impact mitigation strategy introduces a risk of overdevelopment. Shared services were

used as a tool to help overcome fiscal barriers that might have limited the scale of projects. Overdevelopment can lead to long-term fiscal problems for municipalities, particularly when a bust occurs. Collectively, the findings suggest that because rural communities with UOG development are exposed to the whims of the global market, they need to approach shared services with caution.

Conclusion

This paper investigated the interaction between the context of an energy boom and the opportunities present in shared service arrangements for local governments. It sought to (1) document how local governments mitigated stresses to their services in the Bakken shale play, (2) draw connections between the boomtown and shared services literature with the goal of addressing gaps in both, and (3) critique the use of shared services in the context of the rural, isolated boomtown. A key interest was how the motivations for and outcomes of shared services strategies reflected the specific context of the Bakken oil boom. In addition to being rural and remote, Bakken boomtowns experienced hard-to-predict, steep swings in service demands in a context of revenue shortfalls and uncertainty.

Although impacts from UOG development at times overwhelmed Williston and Watford City, the projects profiled here demonstrated a considerable amount of agency and creativity. Shared services were an important strategy in addressing the rapid increases in service demand and the associated problems of limited revenue. These projects demonstrated how shared services could be employed as a strategy to improve

quality of life and the local innovation that communities can deploy in response to shocks such as an energy boom.

Nonetheless, the political economy of the UOG industry and the volatility of revenue streams makes long-term planning for service provision and production difficult. When budgets are flush, there is a risk that communities will finance projects based on volatile revenue sources, overbuild, and/or amass debt that can become burdensome during periods of slowdown in UOG activity. This study found that shared service arrangements could exacerbate these risks.

This study signals several areas for future research. The contributors to over-optimism on the part of local leaders in the specific context of UOG development merit attention from energy impact researchers. In addition, communities need practical advice on opportunities to plan and finance modular development in ways that optimize short- and long-term flexibility. This case study also demonstrates the rewards of expanding the shared services literature into geographies previously overlooked, such as boomtowns or other rural areas experiencing rapid growth.

Finally, the authors would like to end on a note of appreciation for the community leaders who live and work in communities with UOG development. The interviewees in this case study invested significant and often unacknowledged time and effort in developing the projects highlighted here. Many of them volunteered on these projects or extended their work duties far beyond normal expectations. As UOG development rises and falls alongside global oil prices, more work needs to be done at the local level to

understand opportunities, risks, and adaptation strategies to improve local communities' experiences with energy development.

References Cited in Chapter Five

- Alexander, E. R. (1995). *How organizations act together: Interorganizational coordination in theory and practice*. Amsterdam: Gordon & Breach.
<https://doi.org/10.4324/9781315075822>
- Becker, K. (2016). The paradox of plenty: Blessings and curses in the oil patch. In K. Conway, W. Caraher (Eds.), *The Bakken goes boom: Oil and the changing geographies of western North Dakota* (pp. 11–30). Grand Forks: Digital Press at the University of North Dakota.
- Bel, G., & Warner, M. E. (2015). Intermunicipal cooperation and costs: Expectations and evidence. *Public Administration*, 93(1), 52–67.
<https://doi.org/10.1111/padm.12104>
- Bel, G., & Warner, M. E. (2016). Factors explaining inter-municipal cooperation in service delivery: A meta-regression analysis. *Journal of Economic Policy Reform*, 19(2), 91–115. <https://doi.org/10.1080/17487870.2015.1100084>
- Bel, G., Hebdon, R., & Warner, M. E. (2018). Beyond privatisation and cost savings: Alternatives for local government reform. *Local Government Studies*, 44(2), 173–182. <https://doi.org/10.1080/03003930.2018.1428190>
- Benton, J. E. (2013). Local government collaboration: Considerations, issues, and prospects. *State and Local Government Review*, 45(4), 220–223.
<https://doi.org/10.1177%2F0160323X13515683>
- Brenner, N. (2002). Decoding the newest ‘metropolitan regionalism’ in the USA: A critical overview. *Cities*, 19, 3–21. [https://doi.org/10.1016/S0264-2751\(01\)00042-7](https://doi.org/10.1016/S0264-2751(01)00042-7)
- Blair, R., & Janousek, C. L. (2013). Collaborative mechanisms in interlocal cooperation: A longitudinal examination. *State and Local Government Review*, 45(4), 268–282. <https://doi.org/10.1177%2F0160323X13511647>
- Brown, D. L., & Schafft, K. A. (2011). *Rural people and communities in the 21st century: Resilience and transformation*. Malden, MA: Polity Press.
- Bryson, J. M., Crosby, B. C., & Stone, M. M. (2006). The design and implementation of cross-sector collaborations: Propositions from the literature. *Public Administration Review*, 66, 44–55. <https://doi.org/10.1111/j.1540-6210.2006.00665.x>
- Carr, J. B., & Hawkins, C. V. (2013). The costs of cooperation: What the research tells us about managing the risks of service collaborations in the US. *State and Local*

Government Review, 45(4), 224–239.
<https://doi.org/10.1177%2F0160323X13508793>

Charmaz, K. (2005). Grounded theory in the 21st century: Applications for advancing social justice studies. In N. K. Denzin, & Y. S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (pp. 507–35). Thousand Oaks: Sage.

Christopherson, S., & Rightor, N. (2012). How shale gas extraction affects drilling localities: Lessons for regional and city policy makers. *Journal of Town and City Management*, 2(4), 1–20.

Dahle, T. O., Archbold, C. A. (2015). “Just do what you can [...] make it work!” Exploring the impact of rapid population growth on police organizations in western North Dakota. *Police: An International Journal of Police Strategies and Management*, 38(4), 805–819. <https://doi.org/10.1108/PIJPSM-03-2015-0037>

Delabbio, D. J., & Zeemering, E. S. (2013). Public entrepreneurship and interlocal cooperation in county government. *State and Local Government Review*, 45(4), 255–267. <https://doi.org/10.1177%2F0160323X13513272>

Fernando, F. N., & Cooley, D. R. (2016a). An oil boom’s effect on quality of life (QOL): Lessons from western North Dakota. *Applied Research in Quality of Life*, 11(4), 1083–1115. <https://doi.org/10.1007/s11482-015-9422-y>

Fernando, F. N., & Cooley, D. R. (2016b). Socioeconomic system of the oil boom and rural community development in western North Dakota. *Rural Sociology*, 81(3), 407–444. <https://doi.org/10.1111/ruso.12100>

Flora, C. B., Flora, J. L., & Gasteyer, S. P. (2016). *Rural communities: Legacy and change*. Fifth edition. Boulder, CO: Westview Press.

Freudenburg, W. R. (1992). Addictive economies: Extractive economies and vulnerable localities in a changing world economy. *Rural Sociology*, 57(3), 305–332. <https://doi.org/10.1111/j.1549-0831.1992.tb00467.x>

Gilmore, J. S. (1976). Boom towns may hinder energy resource development. *Science*, 191(4227), 535–540.

Gulliford, A. (1989). *Boomtown blues: Colorado oil shale 1885-1985*. Boulder, CO: University Press of Colorado.

Haffner, A., (2017, September 17). The boom’s bill: After years of boom, oil patch cities paying off growth debt. *Bismarck Tribune, Forum News Service*. Retrieved from https://bismarcktribune.com/news/state-and-regional/the-boom-s-bill-after-years-of-boom-oil-patch/article_77d1a657-152e-52f5-871a-650e452c2ee1.html

- Haggerty, J., Kelsey, T., Fahoome, A., Coupal, R., Kay, D., & Lachapelle, P. (2018a). The relationship between oil and gas development and businesses in McKenzie, Richland, Sheridan, and Tioga Counties. Retrieved from <http://www.montana.edu/energycommunities/documents/BusinessFinal-PDF.pdf>
- Haggerty, J. H., Kroepsch, A. C., Walsh, K. B., Smith, K. K., & Bowen, D. W. (2018b). Geographies of Impact and the Impacts of Geography: Unconventional Oil and Gas in the American West. *The Extractive Industries and Society*, 5, 61–633. <https://doi.org/10.1016/j.exis.2018.07.002>
- Haggerty, J. H., Smith, K., Mastel, T., Lapan, J., & Lachapelle, P. (2018c). Assessing, monitoring, and addressing boomtown impacts in the US: Evaluating an existing public health model. *Impact Assessment and Project Appraisal*, 36(1), 115–127. <https://doi.org/10.1080/14615517.2017.1364022>
- Headwaters Economics. (2012, February). County Level Drilling Activity, 2001-2011 Rig Data by Year in Colorado, Montana, New Mexico, North Dakota, Utah, and Wyoming Counties. Analysis summary. Bozeman, MT: Julia H. Haggerty.
- Hefetz, A., Warner, M. E., & Vigoda-Gadot, E. (2012). Privatization and intermunicipal contracting: The US local government experience 1992–2007. *Environment and Planning C: Government and Policy*, 30(4), 675–692. <https://doi.org/10.1068%2Fc11166>
- Hilvert, C., & Swindell, D. (2013). Collaborative service delivery: What every local government manager should know. *State and Local Government Review*, 45(4), 240–254. <https://doi.org/10.1177%2F0160323X13513908>
- Hultquist, A., Harsell, D. M., Wood, R. S., & Flynn, D. T. (2017). Assessing the impacts of transaction costs and rapid growth on local government service provision and delivery arrangement choices in North Dakota. *Journal of Rural Studies*, 53, 14–25. <https://doi.org/10.1016/j.jrurstud.2017.05.003>
- Jacquet, J. (2009). Energy boomtowns and natural gas: Implications for Marcellus shale local governments and rural communities. NERCRD Rural Development. University Park, PA: Northeast Regional Center for Rural Development. Retrieved from https://www.researchgate.net/publication/281900182_Energy_Boom_Towns_and_Natural_Gas_Implications_for_Marcellus_Shale_Local_Governments_Rural_Communities
- Jacquet, J., & Kay, D. L. (2014). The unconventional boomtown: Updating the impact model to fit new spatial and temporal scale. *Journal of Rural and Community Development*, 9(1), 1–23.

- Jimenez, B. S., & Hendrick, R. (2010). Is government consolidation the answer? *State and Local Government Review*, 42(3), 258–270.
<https://doi.org/10.1177%2F0160323X10386805>
- JLG Architects. (n.d.). Williston Area Recreation Center: Williston, North Dakota. Accessed March 16, 2019, from <https://jlgarchitects.com/projects/williston-area-recreation-center/>
- Kay, D., & Corrigan, B. (2018, November 16). An empirical analysis of intermunicipal service sharing and its effects on local government spending in New York State. Community and Regional Development Institute, Cornell University. Retrieved from https://cardi.cals.cornell.edu/sites/cardi.cals.cornell.edu/files/shared/documents/KayCorrigan_EmipiricalAnalysisSharedServicesNYS_2016.pdf
- Keough, S. B. (2015). Planning for growth in a natural resource boomtown: Challenges for urban planners in Fort McMurray, Alberta. *Urban Geography*, 36(8), 1169–1196. <https://doi.org/10.1080/02723638.2015.1049482>
- Kim, Y. (2018). Can alternative service delivery save cities after the Great Recession? Barriers to privatisation and cooperation. *Local Government Studies*, 44(1), 44–63. <https://doi.org/10.1080/03003930.2017.1395740>
- Killelea, Eric. (2013, December 13). DMV to move office to WSC apartments. *Williston Herald*. Retrieved from https://www.willistonherald.com/news/dmv-to-move-o%F4%80%82%A3ce-to-wsc-apartments/article_e6cc416c-640f-11e3-ba18-001a4bcf887a.html
- Kim, Y., & Warner, M. E. (2016). Pragmatic municipalism: Local government service delivery after the great recession. *Public Administration*, 94(3), 789–805.
<https://doi.org/10.1111/padm.12267>
- Kohrs, E. V. (1974, April 24–26). Social consequences of boom growth in Wyoming. Paper presented at the Rocky Mountain American Association of the Advancement of Science Meeting, Laramie, Wyoming. Retrieved from <http://www.sublettewyo.com/Archive/ViewFile/Item/97>
- Kraenzel, C. F. (1955). *The Great Plains in transition*. Norman, OK: University of Oklahoma Press.
- Krannich, R. S. (2017, July 26). Déjà vu...or something new? Community impacts of 21st century energy development through the lens of ‘boom town disruption’ studies. Plenary lecture at Energy Impacts 2017 Symposium, Energy Impacts Research Coordination Network, Columbus, Ohio.

- Lee, M. (2016, November 1). A sports complex and the downside of debt in the oil patch. E&E News. Retrieved from https://www.eenews.net/special_reports/busted/stories/1060045063
- Linden, R. M. (2010). *Leading across boundaries: Creating collaborative agencies in a networked world*. San Francisco, CA: John Wiley & Sons.
- Lindlof, T. R., & Taylor, B. C. (2011). *Qualitative communication research methods*. Thousand Oaks, CA: Sage.
- Loder, T. (2016). Spaces of consent and the making of fracking subjects in North Dakota: a view from two corporate community forums. *The Extractive Industries and Society*, 3(3), 736–743. <https://doi.org/10.1016/j.exis.2016.04.004>
- Markey, S., Halseth, G., Ryser, L., Argent, N., & Boron, J. (2019). Bending the arc of the staples trap: Negotiating rural resource revenues in an age of policy incoherence. *Journal of Rural Studies*, 67, 25–36. <https://doi.org/10.1016/j.jrurstud.2019.02.002>
- McEvoy, J., Gilbertz, S. J., Anderson, M. B., Ormerod, K. J., Bergmann, N. T. (2017). Cultural theory of risk as a heuristic for understanding perceptions of oil and gas development in Eastern Montana. USA. *The Extractive Industries & Society*, 4 (4), 852–859. <https://dx.doi.org/10.1016%2Fj.exis.2017.10.004>
- Measham, T. G., Fleming, D. A., & Schandl, H. (2016). A conceptual model of the socioeconomic impacts of unconventional fossil fuel extraction. *Global Environmental Change*, 36, 101–110. <https://doi.org/10.1016/j.gloenvcha.2015.12.002>
- Morse, R. S., & Abernathy, C. R. (2015). Mapping the shared services landscape. In A. Henderson (Ed.), *Municipal shared services and consolidation: A public solutions handbook* (pp. 143–160). New York: Routledge.
- Newell, R. G., & Raimi, D. (2015). Oil and gas revenue allocations to local governments in eight states. National Bureau of Economic Research, Working Paper 21615. Retrieved from <https://www.nber.org/papers/w21615.pdf>
- Newell, R. G., & Raimi, D. (2018). The fiscal impacts of increased US oil and gas development on local governments. *Energy Policy*, 117, 14–24. <https://doi.org/10.1016/j.enpol.2018.02.042>
- Raimi, D., & Newell, R. G. (2016). *Dunn County and Watford City, North Dakota: A case study of the fiscal effects of Bakken shale development*. Durham, NC: Duke University Energy Initiative.

- Rao, M. (2018). *Great American outpost: Dreamers, mavericks, and the making of an oil frontier*. New York: Hachette Book Group.
- Raudla, R., & Tavares, A. F. (2018). Inter-municipal cooperation and austerity policies: Obstacles or opportunities? In R. Hulst, & A. Van Montfort (Eds.), *Inter-municipal cooperation in Europe: Governance and public management* (pp. 17-41). New York: Palgrave Macmillan.
- Ruddell, R. (2017). *Oil, gas, and crime: The dark side of the boomtown*. New York: Palgrave/Macmillan.
- Shipman, N. A. (2018, January 17). City asks county to help with housing debt. *McKenzie County Farmer*. Retrieved from <http://www.watfordcitynd.com/latest-news/city-asks-county-to-help-with-housing-debt/>
- Smith, K. K., & Haggerty, J. H. (2018). Devolved governance & alternative dispute resolution programs: An example from the Bakken. In K. Brasier, M. Cotton, and J. Whitton (Eds.), *Governing shale gas: Development, citizen participation and decision making in the US, Canada, Australia and Europe (184-197)*. London: Routledge.
- Smith, M. D., Krannich, R. S., & Hunter, L. M. (2001). Growth, decline, stability, and disruption: a longitudinal analysis of social well-being in four western rural communities. *Rural Sociology*, 66 (3), 425–450. <https://doi.org/10.1111/j.1549-0831.2001.tb00075.x>
- Vision West ND. (2012). *City of Watford City, ND: Municipal Infrastructure Needs Assessment*.
- Walsh, K. B., & Haggerty, H. H. (2019). *Social science research in energy communities*. Bozeman, MT: Montana State University, Resources and Communities Research Group.
- Warner, M. E. (2006). Market-based governance and the challenge for rural governments: US trends. *Social Policy & Administration*, 40(6), 612–631. <https://doi.org/10.1111/j.1467-9515.2006.00523.x>
- Warner, M. (2017). *Lessons learned from ICMA's alternative service delivery survey*. Unpublished paper presented at the 2017 ICMA Conference, San Antonio, Texas.
- Warner, M., & Hefetz, A. (2009). Trends in public and contracted government services from 2002–2007. Policy Brief 80. Los Angeles, CA: Reason Foundation. Retrieved from https://web.extension.illinois.edu/lgien/pdf/events/2012-01-19_trends.pdf

- Williston Board of City Commissioners. (2018, September 25). City Commission Meeting. Williston, North Dakota. Retrieved from <https://www.cityofwilliston.com/09.25.18%20Minutes.pdf>
- Wilson, C. E., Morrison, T. H., Everingham, J.-A., & McCarthy, J. (2017). Steering social outcomes in America's energy heartland: State and private meta-governance in the Marcellus shale, Pennsylvania. *American Review of Public Administration*, 47(8), 929–944. <https://doi.org/10.1177%2F0275074016654012>
- Zeemering, E. S. (2017). Why terminate? Exploring the end of interlocal contracts for police service in California cities. *American Review of Public Administration*, 48(6), 596–609. <https://doi.org/10.1177%2F0275074017701224>
- Zeemering, E. S., & Delabbio, D. (2013). *A county manager's guide to shared services in local government*. Washington DC: The IBM Center for the Business of Government.

CHAPTER SIX

EXPLOITABLE AMBIGUITIES & THE UNRULINESS OF NATURAL
RESOURCE DEPENDENCE: PUBLIC INFRASTRUCTURE IN
NORTH DAKOTA'S BAKKEN FORMATION

Contribution of Authors and Co-Authors

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Contributions: Kristin Smith developed the research question and approach. She collected and analyzed the data for the research, and she wrote the manuscript.

Co-Author: Julia H. Haggerty

Contributions: Julia Haggerty supervised the project, offering feedback on the research's development and findings. She also edited the manuscript.

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Introduction

Booms in unconventional oil and gas (UOG) development are often accompanied by parallel booms in public infrastructure investments, a trend that is heightened in rural, isolated resource geographies. Yet, the scholarship on the local impacts of UOG development has failed to address the role of infrastructure in reinforcing or disrupting natural resource dependence. This article applies William Freudenburg's (1992) addictive economies framework to a case study of a large regional water supply project in North Dakota built during an episode of rapid expansion of UOG development in the Bakken Formation from 2009 to 2014. The research deploys an interpretive, qualitative approach to investigating the risk of dependence.

Despite decades of scholarly attention to natural resource economies, the specific pathways and inner workings that shape the evolution of dependence in remote geographies remain opaque. This knowledge gap undermines the search for critical, robust assessments of the impacts of energy development for rural communities, particularly with respect to whether any investment or development strategy can meaningfully enable rural places to "escape the resource curse" (Humphreys et al., 2007). Public infrastructure provides an entry point into this discussion. Infrastructure is often framed as enabling diversification while mutually benefiting industry and the public; however, it can create unexpected and undesired path dependencies. Infrastructure that requires a large amount of debt, is overbuilt, or is overly specialized to the industry can reinforce dependence – even when built to diversify the economy (Freudenburg, 1992; Freudenburg and Gramling, 1992).

Infrastructure is what William Freudenburg (1992) coined an “exploitable ambiguity” in his addictive economies framework: exploitable ambiguities are uncertainties within resource economies that mask symptoms of dependence (such as close alignment with industry, excessive accommodation, or acceptance of volatility) and which can be leveraged by different stakeholders to justify conflicting development strategies. The exploitable ambiguities concept captures the disorderliness of natural resource dependence, suggesting dependence is not an either/or proposition but more complicated – an ongoing process as well as a mixed set of outcomes. This research aims to understand how dependence and exploitable ambiguities coevolve through a case study of a water infrastructure project in northwestern North Dakota, United States.

The project, the Western Area Water Supply (WAWS), addressed the region’s longstanding challenges with water quality and distribution, as well as increased industrial water demand due to UOG development. The Bakken Formation is located in the Northern Great Plains, a prairie region characterized by low population densities and vast spaces. WAWS encompasses a network of reservoirs, pumping stations, and pipelines spanning an area of over five million acres. While water infrastructure is a pressing need throughout rural geographies in the United States, most regions plan for years to achieve only piecemeal infrastructure investments; WAWS stands out for its pace and scale of construction.

The article begins by situating the addictive economies framework within the natural resource dependence literature. The literature review extends the framework by including recent scholarship analyzing the social impacts of UOG development and

infrastructure. A case study on the Western Area Water Supply follows, demonstrating the framework's utility in explicating how natural resource dependence develops on the ground. Specifically, it asks two research questions:

- (1) How are public infrastructure projects shaped by the interactions of the UOG industry and the local context in remote peripheries?
- (2) What is the role of infrastructure in reinforcing or disrupting natural resource dependence?

Literature Review: Infrastructure in Resource Peripheries

Natural Resource Dependence

The risk of long-term natural resource dependence, at national and sub-national scales, constitutes a core preoccupation of natural resource economics and economic geography. There are various approaches to conceptualizing resource dependence and its outcomes (Barnes et al., 2001). Econometric analyses, like those typically employed in the resource curse literature, seek statistical evidence of dependence and the drivers of adverse outcomes (e.g. crowding out effects, industry structure, market volatility), often aiming to model universal concepts (Sachs and Warner, 2001; Ross, 1999). These approaches can integrate social and development metrics, such as by analyzing the relationship between dependence and community wellbeing (e.g. Stedman et al., 2004; Tonts et al., 2012). Alternative “local model” approaches to dependence foreground geographic context and the “messiness, contingency, and disorder” that universalizing approaches tend to ignore (Barnes and Hayter, 2005, 454). Staples theory and critical political economy frameworks operate within this tradition and investigate how

development trajectories are shaped by political, economic, and social histories (e.g. Argent, 2016; Halseth and Ryser, 2017; Tonts et. al., 2013; Walker, 2001; Watts, 2004).

Resource peripheries – remote locations that deliver resources and raw materials to the core of the capitalist system (Wallerstein, 2004) – are especially vulnerable to natural resource dependence and consequently, the least able to do anything about it (Freudenburg, 1992; Halseth and Ryder, 2017). Freudenburg (1992) contended that peripheries might become “addicted” to natural resource dependence despite local decisionmakers’ best intentions to diversify the economy. High sunk costs, cultural alignment with industry, low capacities and access to resources, unequal power dynamics, and other structural constraints limit communities’ abilities to transition their economy beyond resource extraction (ibid.). As natural resource development starts and stops, booms and busts, peripheries are forced to absorb economic shocks with increasingly limited support from higher levels of government (Halseth and Ryser, 2017). While rural resource communities are often innovative in the face of disruption (Smith and Haggerty, 2018; 2019), their ability to overcome economic challenges and leverage resource development into long-term prosperity is constrained.

Within the scholarship on resource dependence and its outcomes, the addictive economies framework is distinguished by an insistence on linking the character of particular extractive industries to the local context. Freudenburg began with the assumption that the question of natural resource dependence is not whether it is a problem – reliance on a single commodity or economic sector is widely acknowledged as undesirable (Halseth, 2016; Tolbert, 2006). Rather, Freudenburg (1992) sought to

problematize the assumption that resource peripheries can realistically avoid overdependence and diversify. His answer was no, and his explanation focused on the interactions between local context, the nature of the extractive activities, and exploitable ambiguities.

Freudenburg (1992, 320) defined exploitable ambiguities as “serv[ing] to mask the inherent unpleasantness of the underlying realities” of resource dependence. He argued that in a global system, industrial development in resource peripheries embodies a set of fundamental ambiguities (volatile price signals, contested understandings of development, and unpredictable surges and contractions in activity). These ambiguities are “exploitable” in the sense that various local actors can interpret them in particular ways that advance their specific agendas and suppress consideration of the fundamental vulnerabilities of resource dependence. Sets of choices among local stakeholders coalesce, albeit unintentionally, to entrench dependence. Exploitable ambiguities introduce a level of unruliness and complexity into questions about the long-term impacts of natural resource development.

Local Impacts of UOG Development

Resource peripheries have unique configurations of surface and subsurface factors, including historical, socio-economic, and geologic variations, that influence their experiences with UOG development (Haggerty et al., 2018). Rural and remote geographies are most likely to experience boomtown impacts, including rapid growth and the risk of becoming overly dependent on a single commodity (Argent, 2017; Jacquet, 2014; Haggerty et al., 2018). The social impacts research on UOG demonstrates that the

benefits, costs, opportunities, and risks from development are distributed unevenly over time, space, and amongst stakeholders (Jacquet and Kay, 2014; Mayer et al., 2018; Schafft et al., 2018; Theodori, 2018). In the short-term, communities typically experience economic benefits from UOG development (Raimi, 2018), though they may be overwhelmed by increased demands on infrastructure and government services (Jacquet, 2014; Measham et al., 2016). The ability for communities to absorb and benefit from the boom is dependent on a host of variables, including access to resources, who owns and controls assets, the scope of development, and governance structures (Haggerty et al., 2018). UOG development and its local impacts are continually evolving due to the industry's fierce competition. Companies routinely implement new technologies to maximize efficiency and reduce costs, at times addressing community impacts and at other times creating new ones.

UOG development in the US is complicated by its devolved governance and resulting patchwork of state-specific institutions that regulate the industry (Jacquet et al., 2018a; Rabe, 2014; Zirotiannis et al., 2016). The market primarily controls the pace and scale of UOG development, as opposed to local, state, or federal governments (Witt et al., 2018). Industry is not required to conduct formal social impact assessments or monitoring processes when development occurs on private land, leaving companies to selectively choose when and how to self-regulate community impacts, as well as which impacts to address (Haggerty and McBride, 2016; Wilson et al., 2017). Landowners can shape how UOG development occurs on their land, but this "private participation" form of planning often does not address regional or cumulative impacts (Jacquet, 2015). As community

and economic development responsibilities are increasingly devolved (Ryser et al., 2019), local communities are expected to manage the overwhelming impacts associated with UOG booms while implementing plans for economic diversification – all within a context of limited support, resources, and capacity (Halseth, 2016). The results are mixed (e.g. Haggerty et al., 2019; Malin and DeMaster, 2016). While the regulatory void surrounding UOG development creates opportunities for adaptive and creative solutions, the range of local capacities and skillsets available to manage UOG impacts often cannot overcome structural economic vulnerabilities (Silva and Crowe, 2015; Smith et al., 2019; Smith and Haggerty, 2020).

Infrastructure in Resource Peripheries that Host UOG

The long-term impacts of infrastructure and its funding mechanisms are largely overlooked and undertheorized within the boomtown, resource dependence, and energy impacts scholarship. Natural resource extraction requires significant capital investments, both from companies looking to develop the resource and from local governments hoping to encourage the industry's development (Drache, 1995). This is especially true in remote regions that have limited infrastructure necessary to support rapid development and population growth (Gilmore, 1976; Haggerty et al., 2018). Planning and constructing infrastructure in the context of resource booms involves a distinct set of challenges: uncertainty regarding population growth, time lags between impacts and funding availability, and whether infrastructure should be built to accommodate peak demand or long-run averages (Cummings and Mehr, 1977). As researchers question the boom/bust binary of boomtown impacts (Jacquet and Kay, 2014; Schafft et al., 2018), infrastructure

has the potential to complicate and expand assumptions about the temporal aspects of UOG development and the risk of resource dependence.

The structure of the UOG industry produces distinct impacts that exacerbate infrastructure challenges within boomtowns. The UOG industry consists of a range of large and small, multi- and transnational corporations, as well as a host of oilfield service companies and sub-contractors (Bridge and Le Billon, 2017; Small et al., 2014). As companies come and go, consolidate and go bankrupt, this complicated space is fraught with uncertainty, making it difficult for communities to create long-term plans or build trust with industry (Jacquet and Kay, 2014; Fleming et al., 2015, Luke et al., 2018). Further, UOG requires extensive capital, labor, and infrastructure as wells are drilled thousands of feet deep (and long), and resources must be transported over vast distances for processing (Murphy et al., 2018). While UOG development has a dispersed geographic footprint, its development within the region is locally uneven (Junod et al., 2018), creating questions about where development will occur and when (Jacquet and Kay, 2014). Due to the sheer scale and pace of UOG development, public infrastructure is often built rapidly and reactively (Grubert, 2018), which can create its own set of cascading impacts that can persist into and beyond downturns in development.

There is often an assumption that municipalities receive enough revenues from resource development to mitigate boom impacts, but this is not always not the case (Enoch and Eaton, 2018; Haggerty and Haggerty, 2015; Newell and Raimi, 2018). In some geographies, the costs of public infrastructure investments may outweigh the local benefits of resource development, particularly if tax breaks are given to industry (e.g.,

Drew et al., 2018; Tonts et al., 2013). Souza et al. (2018) describe this risk as a “resource-return mismatch.” Infrastructure is thus contradictory, offering promises of economic development but simultaneously risks of increased vulnerability, such as through unsustainable debt service costs or entrenching undesired path dependencies (Appel et al., 2018; Howe et al., 2016;).

To summarize across this literature, the risk of resource dependence is heightened in rural and remote geographies due to political-economic structures, limited capacity and access to resources, and tendencies to over-accommodate industry due to lack of alternatives. This article conceptualizes natural resource dependence as a spectrum in which levels and versions of “addiction” vary across geographic scales: an infrastructure project may simultaneously disrupt dependence at one scale while reinforcing dependence at another, highlighting what Furlong (2019) describes as the contradictions and incoherencies of infrastructure. The addictive economies framework was chosen because it investigates the question of resource dependence by bringing the ambiguities and contradictions of infrastructure to the forefront.

Case Study: The Western Area Water Supply project (WAWS)

The Western Area Water Supply Project (WAWS) grew out of long-recognized problems with water quantity and quality in western North Dakota (Hearne and Fernando, 2016). Prior to the formation of WAWS, five separate districts supplied water from a combination of surface and groundwater sources, albeit in an uncoordinated and piecemeal fashion. The boom in UOG development dramatically increased water

demand¹, creating the risk of water shortages. An engineering firm proposed WAWS as the most cost-effective solution to expand rural water access while meeting industry's ever-increasing thirst. The project doubled the capacity of the Williston Regional Water Treatment Plant, built an extensive pipeline system for distribution, and created a water authority to manage coordination between the five water districts (North Dakota State Water Commission, 2017). The water entities operate under the WAWS Authority but retain separate governing boards. WAWS subsumed their pre-existing debt and financed new infrastructure. In return, the water districts buy wholesale water from WAWS.

WAWS is notable for its unique but controversial financing model. Rural water projects are typically funded through a mix of federal and state grants, loans, and local taxes. They often take decades, with small sections built incrementally as funding becomes available. In contrast, WAWS did not rely on grants or federal funding, at least initially. Instead, its business plan called for 80% of the project to be repaid via water sales to UOG companies. The Authority leveraged this expected revenue source to secure loans from the Bank of North Dakota for the project's capital costs, enabling an extraordinarily fast buildout. Supporters promoted the project as a public-private partnership (P3) in which industry would help pay for the water system. However, the P3 strategy and its implementation have proven problematic. Decreases in oil prices in 2014 prompted fiscal troubles for WAWS due to lagging industrial water sales (Stantec Consulting Service, Inc., 2018). Additionally, private water companies that also supplied

¹ Water use for UOG extraction in western North Dakota increased from 550 million gallons in 2008 to 10.2 billion gallons in 2014, while rural and municipal water demand also expanded rapidly (Lin et al., 2018).

water to the UOG industry worried about losing sales to WAWS and actively lobbied against the regional authority, creating a well-publicized controversy (e.g., Kusnetz, 2012; Scheyder, 2013; Smith 2013).

As depicted in Figure 6.1, the project's scale is enormous, financially and geographically. As of 2018, the WAWS Authority had over \$360 million in loans and grants (Stantec Consulting Services, 2018), and an estimated final cost of over \$460 million (WAWS, 2018). From 2011 to 2017, WAWS built over 1,700 miles of pipeline, two water towers, ten pump stations, and ten reservoirs (North Dakota State Water Commission, 2017). The project served 60,000 people in 2019 and could eventually serve 125,000 (WAWS, 2019). While WAWS appears in the literature on industry's water supply needs in North Dakota (e.g. Hearne and Fernando, 2016; Horner et al., 2016; Kurz et al., 2016; Lin et al., 2018), it has not yet attracted detailed analysis.

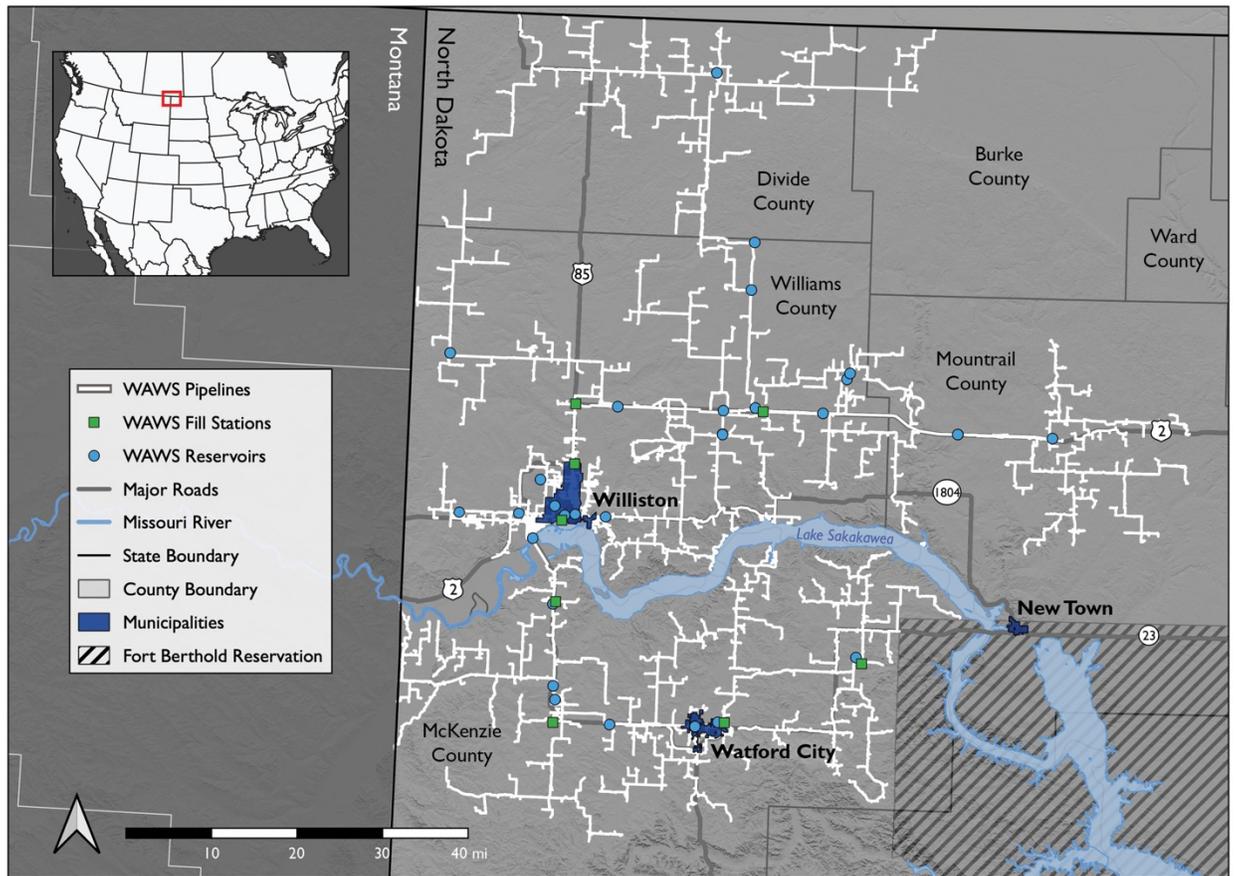


Figure 6.1. The geographic extent of the Western Area Water Supply Project, including pre-existing and new pipelines.

Data sources: WAWSP Authority, North Dakota GIS Hub, Montana State Library Clearinghouse, U.S. Census Bureau, USGS. Data downloaded 11.01.2019.

Map credit: Jackson Rose.

Case Study Methods

This case study uses a mixed-methods approach, drawing upon semi-structured interviews with WAWSP stakeholders and content analysis of testimonies from the North Dakota Legislative Assembly. Over 5,200 pages of transcribed testimonies were analyzed from six bills spanning from 2011 to 2017: HB 1206 (2011), HB 1020 (2013), SB 2233

(2013), HB 1140 (2013), SB 2020 (2015), and HB 1020 (2017). The twenty-two stakeholder interviewees included WAWS organizers (4), local government employees and officials (5), state government employees (4), private water industry (1), engineers associated with the project (2), and landowners that host WAWS infrastructure on their property (6). Interviews were transcribed verbatim and uploaded into NVivo for analysis. Additional background research was conducted by reviewing news articles, WAWS board meeting minutes and studies, Industrial Commission meeting minutes, and WAWS promotional materials. The first author also attended relevant state and local meetings during extended stays in North Dakota in 2016, 2017, and 2018.

The initial data findings illustrated a contradiction: at times WAWS suggested strong adaptability while at other times it reinforced resource dependence. This contradiction led to the hypothesis that the project was serving as an exploitable ambiguity as described by Freudenburg's (1992) addictive economies argument. The analysis shifted towards investigating the drivers of "economic addiction" with a focus on the ambiguities encompassed by the infrastructure project. The interviews and specific sections of testimony were re-coded. Significant attention was paid to the "messy" aspects of the project, including how the nature of the UOG industry shaped decisions related to the project. Categories were continually expanded, collapsed, and refined during repetitive coding sessions. Analysis focused on comparing and contrasting emergent themes with the literature in the spirit of a constant comparative approach (Lindlof and Taylor, 2011).

Findings: The Exploitable Ambiguities of WAWS

This article identifies the timeframe, financing, and scale as exploitable ambiguities within the WAWS project and then investigates how stakeholders attempted to resolve these ambiguities. Each of these dynamics reveals how the nature of the UOG industry intersected with the region's unique context to create the opportunity, albeit one that is highly constrained, to reimagine the region's water systems.

Exploitable Ambiguities: Timeframe, Financing, and Scale

The pace of UOG development and industry's need for consistent water supply created challenges related to the timeframe, financing, and scale of WAWS infrastructure. The spike in industrial and residential water demand clashed with the long timeframe that regional water supply projects typically require – often decades. Decision-makers designed WAWS to be a “quick fix” for industry's immediate water needs while providing residents, new and old, access to potable water. However, the project prompted questions that did not have straightforward answers given the industry's volatility: in what timeframe should it be built? Who should pay for it? What should be the scale? This section explores how these uncertainties developed, allowing stakeholders to leverage “exploitable ambiguities” to justify their agendas.

In What Timeframe Should It Be Built? Time lags often exist in boomtown settings between infrastructure needs, funding availability, and completion (Cummings and Mehr, 1977). In the case of WAWS, the whirlwind nature of UOG led to a sense of urgency to build the project. Ron Ness, President of the lobbying group North Dakota

Petroleum Council, testified on behalf of WAWS: “Timeliness is important on this project. The demand for water is going to outpace the supply. We are going to need all the sources we can access. It is critical to plan for it now” (Senate Appropriations Committee, HB 1206, April 1, 2011). During another hearing, State Representative George J. Keiser testified, “Speed is the key. The oil business out here needs the water today” (Energy and Natural Resources Subcommittee, HB 1206, January 26, 2011).

While the project’s advocates acknowledged the risks of over- or under-building WAWS due to the industry’s volatility, they still promoted its expeditious construction.

Assumptions about current and future levels of UOG extraction justified the project’s immediate construction.

While the sense of urgency spoke to real concerns about the region’s water supply, it also limited debate. In some instances, government officials decided to forgo procedural conventions to expedite WAWS. When state representatives noted that water supply systems are typically voted on by the public, other decisionmakers argued against holding an election. The mayor of Williston testified, “We’ve been trying to fast track because we’re up against the gun now. Even if we have a special election, it would delay things...I’m afraid that we may not get some of the aspects of the project done this year” (Energy and Natural Resources Subcommittee, HB 1206, February 10, 2011). The Authority was also given a “quick take” option for eminent domain², a decision designed to speed up the project due to the region’s “imminent need for water” (Energy and

² Eminent domain is the ability of the government to take private property for public use. The laws governing when and how the state of North Dakota can take private property are outlined in Century Code, Chapter 32-15.

Natural Resources Committee, HB 1206, Tami Norgard page 5, January 20, 2011).

Legislators' willingness to allow exceptions to common practice illustrates the magnitude of the perceived water crisis and their political inclination to accommodate industry.

Who Should Pay for It? WAWS's financing strategy was a direct outcome of the uncertainties related to the timing and scale of the region's water infrastructure needs. The WAWS board members proposed the public-private partnership (P3) model – and it was endorsed by the Legislative Assembly – because it allowed for an accelerated solution to industry's need for water when compared to conventional financing models. In North Dakota, water supply projects are prioritized and funded by the State Water Commission. Historically, the Commission's budget has been volatile due to swings in federal funding (e.g., North Dakota State Water Commission, 2017). Organizers for proposed water projects had to line up each biennium to request a portion of the small but unpredictable budget. Northwestern North Dakota was often not a high priority due to its low population density.

WAWS leaders felt the standard processes for financing water projects were too slow, fragmented, and unreliable to accommodate WAWS's expedited buildout schedule. As one WAWS proponent explained, "In order for the oil to continue and not have a major catastrophe on our hands we had to fast track this process. We just couldn't build it over 30 years, and that's what we told the state." Additionally, accepting federal funds could have exposed WAWS to litigation risks³. One of the defining features of the

³ The Northwest Area Water Supply is another large regional water supply project in northcentral North Dakota. Although construction began in 2002, as of 2020 it still has not been completed due to litigation

project was to redirect the region's water supply so that it originated primarily from one source – the Williston Regional Water Treatment Plant, which serendipitously had an oversized senior water permit. By leveraging the pre-existing permit, refusing federal money, and using a P3 model that relied heavily on loans, WAWS was able to circumvent regulatory requirements and avoid potential lawsuits (Hearne and Fernando, 2016). The funding for WAWS could have relied on other sources, but the P3 funding allowed the Authority to access capital and begin construction quickly.

What Should the Scale Be? The rapid pace and uncertainties associated with the duration of the UOG development complicated typical processes for defining the scale of WAWS. Engineers plan projects based on long-term averages, but the UOG development introduced many unknowns: it was unclear how many people would move to western North Dakota and how long they would stay, which cities would absorb the new population growth, and where and when the industry would develop specific locations. North Dakota State University developed population projections to assist with planning decisions, but their estimates ranged wildly from 50,000 people in 25 years to 160,000 people. As one engineer explained:

But we have to build at least some long-term flexibility into [WAWS]. And the population and growth models...out here – they suck. We don't know what's coming in five years, let alone 25 or 50. It's really hard to say that this [boom] is going to survive for that long. Or [if] it's going to meet our needs. We did the best we could.

over its Environmental Assessment (Hearne and Fernando 2016). WAWS leaders were familiar with NAWS and eager to avoid a similar situation.

After six years of construction, engineers were still undecided about whether WAWS was built for the correct population projections. As one put it, "... we're still waiting to see what the crystal ball tells us." Uncertainty and the lack of reliable information are classic challenges for boomtown communities (Jacquet and Kay, 2014). Industry's plans about the timing, location, and volume of drilling within a given play are often not public, leaving local governments to make best guesses about the scale of infrastructure investments (Haggerty and McBride, 2016). For WAWS, the materiality of the infrastructure clearly conflicted with the volatility imposed by the UOG industry, establishing risk for under- or over-building the project that was nearly impossible to mitigate.

Importantly, the collaboration between the five water entities and reliance on industrial water sales enabled the organizers to overcome the high cost per capita that had historically prevented a water system in this region. The financing structure allowed WAWS to be built larger and in more sparsely populated geographies than might have been funded through normal processes. However, this prompted debate about the project's scale, with some stakeholders arguing it was overbuilt and others arguing it was underbuilt. While WAWS was a strategic, coordinated response to secure funding for the region that had previously been denied this capital, the UOG development created uncertainties about the timing, financing, and scale of the project that were leveraged by different stakeholders.

Grappling with and Leveraging Exploitable Ambiguities

It is not surprising that when local leaders saw an opportunity to build a regional water system that addressed multiple water entities' needs and circumvented conventional funding processes, they took it. The decision to finance WAWS using the P3 model allowed an accelerated construction process but also raised questions about whom the project benefitted – the industry or the public. The extent to which WAWS was designed simply to accommodate the UOG industry was and continues to be debated. WAWS was rarely discussed in the Legislative Assembly without mentioning the UOG industry, and it was widely acknowledged that it would not have been possible – at least at its current scale – without the boom. Critics of WAWS questioned whether selling water to industry was an appropriate role for government. As one landowner complained, “This was a state-driven project to milk some more money out of the oil field.” The ambiguities surrounding the project, coupled with the high financial stakes of UOG development, led WAWS to become entangled in unexpected, cutthroat political debates.

Long-time residents were familiar with the uncertainties associated with oil and gas development, which has proceeded episodically in the Bakken region since the 1950s. Many of the local leaders involved with WAWS lived through the most recent oil bust in the 1980s and cited that experience as informing their current decision making. A government employee emphasized how infrastructure is one way to ensure long-term local benefits from UOG development:

You're smart to take from [the boom] what you can because when these things go away at least you want good roads, at least you want good hospitals, at least you want good water distribution systems and electric

grid...When you have less oil out there you have something to do the next level.

Local leaders viewed the boom as an opportunity and leveraged the boom's uncertain timeframe to justify the project.

Similarly, local and state leaders grappled with the question of who should pay for infrastructure investments. One interviewee described WAWS's financing strategy as a tool to recoup costs imposed by industry:

Why not come up with a plan where – because of the industry that is creating this situation – is there a way that we can implement a plan that would not necessarily hold them accountable, but they can also share in some of the pain? And help pay for some of these projects to bring reliable drinking water to the communities that need it because of growth.

The above quote reflects a desire to have the industry internalize some of its costs. The P3 model helped accomplish this goal. Similarly, others argued that the P3 financing could help minimize taxpayer costs while capturing long-term benefits from the UOG development. As Vice Chairman of the Senate Appropriations Committee Bill L.

Bowman testified, "There is definitely risk and no one can deny that...[But] if this thing works and it pays for itself, there will be revenues coming in. And, that will benefit every person in this state" (Senate Appropriations Appropriation Committee, HB 1206, April 1, 2011). For local and state decisionmakers, the ambiguities surrounding WAWS's financing were used to highlight the project's benefits.

The stakeholders who opposed WAWS cited the project's exploitable ambiguities to justify their agenda – perhaps best exemplified by the opposition to WAWS from the Independent Water Providers. Some private water companies viewed WAWS's industrial sales as a threat to their business model. The Independent Water Providers formed in

2011 in reaction to WAWS and actively lobbied against the project at the Legislative Assembly. Their testimonies reflected fierce debates about the intention of the project. One water provider testified, “This bill is not about bringing treated water to the areas that need it. It is all about the water sales to the oil industry” (Senate Appropriations Committee, HB 1206, April 1, 2011). The Independent Water Providers’ lobbyist Robert Harms directly referenced the project’s exploitable ambiguities during his testimony: “We like the idea of having additional infrastructure, but it should be sized correctly and priced correctly. We think that one-third the size of the project that you’re talking about today would be more on the order of what northwest North Dakota needs” (Energy and Natural Resources Subcommittee, HB1206, February 9, 2011). Harms questioned the scale of the project to make a broader argument against the project: the larger the scale, the more likely WAWS would detract from private companies’ sales.

The Independent Water Providers successfully lobbied to have restrictions imposed on WAWS that limited their ability to sell industrial water, constraining its economic viability. Private water companies are an often-unacknowledged component of the oil industry, but companies can make millions of dollars selling water for hydraulic fracturing and well maintenance. The heightened rhetoric of the Independent Water Providers reflected these high stakes. WAWS’s exploitable ambiguities – the timeframe, financing, and scale – created uncertainties about the need and benefactors of the project that the Independent Water Providers leveraged into an effective anti-WAWS campaign.

In response, WAWS board members were frustrated by the Independent Water Providers' accusations that the project benefited industry over the public. As one interviewee explained:

But, the water industry hates us. They're highly funded, and they spend a lot of money trying to discredit what we're doing. And, I'm being biased, okay? We just don't get to tell our story very often because we have to be so politically correct about it. But it's bullshit. It really is.

WAWS organizers continually reiterated that their intentions were to increase access to water to rural residents, noting that industrial water sales were a means to an end and that they – as volunteer members of the WAWS board – did not benefit directly from the project. An engineer reinforced their intentions: “It's not that we're trying to make anyone broke or take their market share. It's truly just to supply reliable drinking water to the region.” To some extent, WAWS organizers understood the Independent Water Providers' viewpoint, noting that “if you're in oil country, industry – they're not good or bad – they're fiscal animals. They're going to do what they can to protect their profits and their companies.” Other WAWS board members bristled at the idea of commodifying water for private interests. This range of political viewpoints about water and the role of government reinforces the complexity of rhetorical and ideological stances available to WAWS stakeholders. It highlights the ambiguities embedded within WAWS that critics, like the Independent Water Providers, could exploit to undermine the project's political and financial viability.

Ongoing Uncertainty and Long-term
Impacts of Infrastructure

WAWS disrupts dependence. Community leaders were able to leverage the oil boom to transform the region's water distribution network. In this light, WAWS is an innovative project that speaks to the adaptability of the region. WAWS united five separate water entities, some of which had previously clashed over boundaries. The Authority provided a formal process for the water entities to create a collaborative water management system, including helping to coordinate financing so the entities no longer had to compete against each other for scarce state funds. As a water commissioner testified, "They've even resolved a territorial dispute that has gone on over ten years..." (Energy and Natural Resources Subcommittee, HB 1206, January 26, 2011). By working together, the entities were able to overcome divisions and build infrastructure so that rural landowners had access to potable water – a first for many of these residents. From this perspective, the Authority illustrates an immense amount of adaptability, an openness to reimagining existing institutions, and a willingness to overcome political divides, all strong indicators of positive community development.

WAWS was also a strategic economic development investment. Advocates argued it would help diversify the economy and mitigate against downturns in industry activity. Local leaders hoped WAWS could be used to attract potash, gasification, or agriculture processing plants to help diversify the economy. As one local leader reflected, "How do you develop jobs without manufacturing? Without rail? Without water? Now we've got the infrastructure." WAWS was repeatedly referred to as a basic building block for economic development, though there were no specific plans on how to use the project

for economic diversification. The promise of infrastructure's benefits to both the industry and the public was a frequent theme in the data.

WAWS Reinforces Dependence. However, the long-term impacts of WAWS's financing and its risks were unacknowledged. While most water supply projects in North Dakota are 60-75% grant-funded, WAWS was initially funded with loans due to the project's perceived urgency and the assumption of strong industrial water sales (Stantec Consulting Services, 2018). The Authority's ability to repay its loans and avoid defaulting relied on selling water to the UOG industry, a volatile source of revenue, as demonstrated by Figure 6-2. WAWS's financial sustainability was questionable during many months between 2015 and 2017 when global oil prices sagged. These funding shortfalls are indicative of a downturn in industrial sales due to plummeting oil prices, as well as concessions to the Independent Water Providers that limited WAWS's ability to sell industrial water. During the 2017 legislative assembly, the Bank of North Dakota consolidated and refinanced WAWS's loans to lower payments in response to the decrease in UOG activity. Nevertheless, WAWS's success was and continues to be dependent on UOG production.

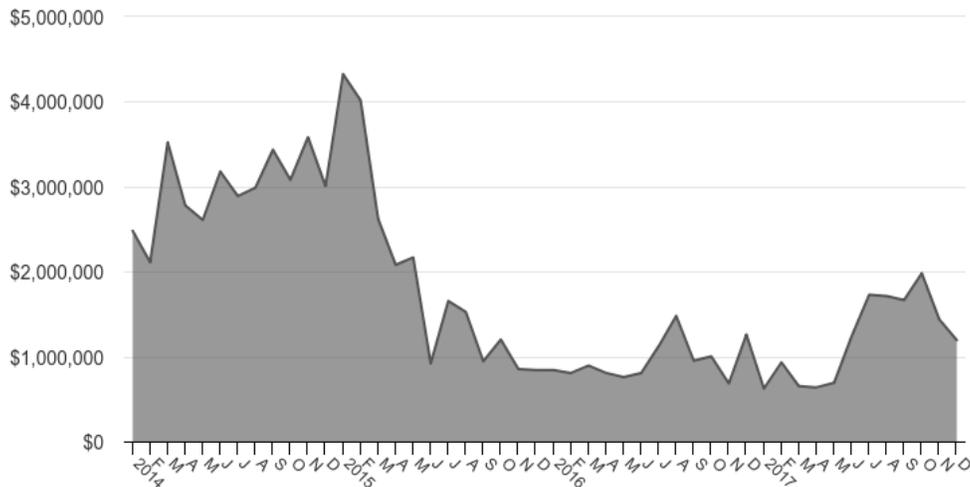


Figure 6.2. Volatile industrial water sales challenged WAWS's financial viability. Source: Western Area Water Supply Authority, 2018.

The question of who carries the risk is critical for evaluating the long-term outcomes of infrastructure investments. Neither the WAWS board, the Legislative Assembly, nor the Bank of North Dakota adopted measures to mitigate against the potential volatility of industrial water sales. While P3 best practices encourage transparent, defined relationships between entities (NCPPP, n.d.), WAWS did not sign formal contracts with industry. During the 2011 legislative session, five major UOG companies testified in support of WAWS, including Halliburton, Whiting Oil & Gas Corporation, Hess, XTO Energy, and Samson Resources Company. Additionally, the President of the North Dakota Petroleum Council testified multiple times on behalf of WAWS, noting that industry had been meeting with community members in western North Dakota regarding a water solution since 2009. Although these companies advocated for WAWS and stood to benefit from the project, they did not financially invest in the project. During the first committee meeting on WAWS in 2011,

Representative Marvin Nelson asked, “Are the oil companies in any way making a commitment to the project as far as to buy?” (House Energy and Natural Resources Committee, HB 1206, January 20, 2011). Representative Nelson was told that the oil companies would not be entering into long-term contracts. Instead, the 2011 negotiations resulted in the Bank of North Dakota issuing loans for WAWS that were backed by the State Water Commission and the state’s moral obligation⁴. This effectively shifted the project’s fiscal risk to the taxpayers of North Dakota.

In hindsight, formal contracts with industry could have reduced the volatility of the revenue stream, decreasing the project’s exposure to the global commodities markets and mitigating some of the dangers of reinforcing dependence. The financial analysis conducted by Stantec Consulting Services (2018) underscored the need for the WAWS Authority to adopt a new strategy to manage volatility and shift some of its risk to the private sector, such as through multi-year concession offerings to private companies with both upfront and fixed payments. As noted throughout this paper, WAWS was built to achieve benefits for the region, but its initial financing plan created long-term risks. The ambiguity of whether the benefits outweigh the risks exemplifies the challenges of building public infrastructure during the frenzy of an UOG boom: local leaders must make practical decisions, but it is often unclear how these decisions will disrupt or reinforce natural resource dependence.

⁴ While a moral obligation is not legally binding like a general obligation, if WAWS defaulted on its loans and the state ignored its moral obligation it would damage the state’s credit rating. In 2017 WAWS notes were consolidated, and the moral obligation was superseded by including the Resources Trust Fund as a secondary source of repayment.

Discussion: The Role of Infrastructure in Addictive Economies

This research extends William Freudenburg's (1992) addictive economies framework to analyze the nuances of public infrastructure in the context of a rural region with UOG development. The findings suggest that the long-term impacts of WAWS are mixed. On the one hand, WAWS is a project that promotes collaborative water management and illustrates high levels of community innovation. On the other hand, WAWS's financing strategy reinforced dependence on the oil industry, raising questions about whether it represented future diversification or long-term "over-adaptation" – the notion of developing local assets so specifically for a particular industry that future alternatives are actually constrained. WAWS's seemingly contradictory long-term impacts are vital to understanding the inner workings of natural resource dependence.

Infrastructure Decisions Are Shaped by Industry Structure and Local Context

Studying infrastructure in communities that host UOG reveals how the nature of the industry shapes decision making. The UOG industry's dispersed footprint and intensive labor demands increased water demand throughout the region (Hearne and Fernando, 2016; Horner et al., 2016), prompting the WAWS project. Given the vastness – and the industry's immediate need for water – the standard financing tools for water infrastructure were too slow and fragmented. Thus, WAWS leaders chose the P3 financing strategy that took advantage of Williston's pre-existing water permit, the UOG industry's regional needs for freshwater, and appeased their frustrations with federal and state water funding processes. While formal contracts with UOG companies would have

helped spread the fiscal risk, whether a partnership with industry is even possible is unclear given the lack of coordination between industrial stakeholders. Due to the volatility of global oil markets and the fierceness of competition, companies have little incentive to partner with a public entity and expose themselves to unnecessary fiscal risk. These factors reinforce previous scholarship suggesting that the impacts of UOG development are overwhelming to local governments (Haggerty et al., 2019; Halseth, 2016).

In response to calls for more research on the “black box” of industry (e.g., Bridge and Le Billon, 2017), the WAWS case study demonstrates how chaotic and fragmented the UOG industry is in practice. The controversy surrounding the Independent Water Providers demonstrates that the UOG industry is marked by multiple and, at times, competing interests. While major oil field service companies testified in support of the WAWS project, the Independent Water Providers – a group of midstream water companies – were the project’s most vocal critics. Their lobbying led to the legislature limiting WAWS’s industrial sales, to the benefit of some in the UOG industry and the detriment of others. This case study illustrates the need for energy impacts scholars to directly address the complexity of the UOG industry and how industry’s entanglements of contractors and sub-contractors, hedge funds, and businesses shape and constrain communities’ decision making.

Infrastructure Is a Promise and a Peril in Natural Resource Economies

WAWS proponents, from the local to the state level, firmly believed that the project was a promising investment in their economic future. However, as Freudenburg

(1992) noted, the question is not the intent of economic diversification strategies but instead if economic diversification is even possible given the conditions of operating as a natural resource periphery. While WAWS could result in economic diversification, there was not a specific plan for the region to take advantage of the infrastructure and plan for a post-UOG economic future. The difficulty of identifying the future purposes of the project stems from the challenges imposed on communities with UOG. The chaotic, unregulated pace of UOG increases the likelihood that community planning will become intertwined with the industry's development – a risk that WAWS exemplifies as the boundary between a public works project and industrial infrastructure became blurred. Whether WAWS primarily benefits public or industry interests remains an open question.

Resource peripheries are especially vulnerable to natural resource dependence (Halseth, 2016), and this case study provides evidence that infrastructure investments can simultaneously disrupt and reinforce dependence. Given UOG's devolved governance, local communities must figure out how to mitigate undesired impacts on their own (Jacquet et al., 2018b; Kinne, 2018; Wilson et al., 2017). Devolution can create opportunities for community agency and result in creative solutions (Markey et al., 2019). The tradeoff, however, is that communities may implement solutions that create new, unexpected problems. The P3 funding allowed WAWS to build a project that was more extensive and remote than would probably be funded by the State Water Commission under normal circumstances. While WAWS increased water access for rural residents, having water available in remote places throughout the oil patch was also an obvious benefit for UOG companies. Was WAWS overbuilt? Was the benefit of serving

remote residents worth the cost of the project? These questions are still being debated, both locally and at the North Dakota Legislative Assembly, and do not have obvious answers. On a practical level, the ambiguity surrounding the benefits and costs of infrastructure needs to be acknowledged when communities with UOG development are considering building new public infrastructure.

Despite the challenges, the WAWS project also illustrates the immense amount of innovation that can occur in resource peripheries. Community leaders strategically and intentionally leveraged the boom to make this project possible, often drawing upon their previous experiences with oil and gas development to do so. This finding reinforces research by Grubert (2018) and Becker (2016), who identify the importance of historical experiences with oil and gas development in shaping current decisions. From this perspective, WAWS demonstrated the ability of the region's leaders to learn and problem solve in the face of enormous change and uncertainty. The decisions related to WAWS are not merely a product of constraints imposed by UOG development. Rather, WAWS demonstrates how community leaders in the Bakken addressed water challenges imposed by UOG development by being willing to reimagine their governance and infrastructures. The local context and problem-solving capacities in resource peripheries are often unacknowledged in natural resource dependence scholarship, perhaps because it can be unclear if community actions are reinforcing or disrupting dependence. However, this unruliness of natural resource dependence offers important lessons for understanding the full extent of the challenges and opportunities facing local communities that host UOG development.

Practical Implications

Public infrastructure decisions in UOG communities are made in a context of high uncertainty – not an ideal situation when infrastructure is built to last for decades, and its costs can range into the hundreds of millions of dollars. The WAWS case study highlights several points of practical advice. First, there is a mismatch between industry’s short-term goals and the long-term implications of assuming extensive debt. Community leaders need to understand the range of benefits and risks of infrastructure decisions with a particular emphasis on debt service, maintenance, and opportunity costs. Whenever possible, the infrastructure should be linked with concrete future economic plans. Assumptions that an investment in public infrastructure will automatically lead to economic diversification are not sufficient given the volatility and constraints of UOG development. Second, the project should be decoupled from UOG development, including its financing. The project should be financially viable whether the global oil price is high or low.

Perhaps most important, the WAWS case study exposes how fiscal policies and regulations are failing communities that host UOG. Previous research demonstrates the importance of fiscal policy and revenue sharing for helping communities avoid dependence (Argent, 2013; Haggerty, 2012; Newell and Raimi, 2015). Guaranteed revenue sources can ease volatility associated with global markets (Markey et al., 2019). The regulatory void surrounding UOG allows industry to develop without communicating or coordinating with local governments, forcing governments to make decisions with highly uncertain data. Better regulations and predictable revenue sources

would greatly benefit regional development efforts in the Bakken as community leaders attempt to leverage the UOG boom into long-term benefits.

Conclusion

Infrastructure investments in communities with UOG warrant more attention from scholars researching energy impacts or natural resource dependence. This case study demonstrates that infrastructure is rife with exploitable ambiguities, which can be leveraged by different stakeholders to justify various development strategies, complicating assumptions about who benefits and who subsumes the risk in UOG development. The contradictory assessments of WAWS, as both innovative solution and risky endeavor, speak to these challenges and the uncertainties community leaders face as they make decisions about public infrastructure.

This case study opens up new avenues for research on the relationship between public infrastructure, path dependencies, and natural resource dependence. Infrastructure in resource peripheries often exemplifies a tendency for industry to externalize its costs to the public. Public infrastructure investments – like those for water, wastewater, electric, or transportation systems – are often geographically expansive, tend to be expensive, and thus have high sunk costs and opportunity costs. This research suggests that Freudenburg’s (1992) addictive economies framework is useful for highlighting the ambiguities and contradictions that are created when community leaders address impacts of UOG development through infrastructure solutions. Further, this case demonstrated the limits of discussing “industry” as a monolithic entity and the need to provide more nuance with regards to the many stakeholders that make up industry. Public infrastructure

is an unruly and complex feature of the development landscape, offering the potential for both critical and applied insights on the experiences of resource peripheries with energy development.

References Cited in Chapter Six

- Appel, Hannah, Nikhil Anand, and Akhil Gupta. 2018. Introduction: Temporality, Politics, and the Promise of Infrastructure. *The Promise of Infrastructure*. Durham: Duke University Press: 1-40.
- Argent, Neil. 2013. Reinterpreting core and periphery in Australia's mineral and energy resources boom: an Innisian perspective on the Pilbara. *Australian Geographer* 44(3), pp. 323-340.
- Argent, Neil. 2016. Australia – trap or opportunity? Natural resource dependence, scale, and the evolution of new economies in the space/time of New South Wales' Northern Tablelands. In Greg Halseth, Editor, 2016. *Transformation of Resource Towns and Peripheries*, New York: Routledge, pp. 18-50.
- Argent, Neil. 2017. Rural geography I: resource peripheries and the creation of new global commodity chains. *Progress in Human Geography* 41(6), pp. 803-812.
- Barnes, Trevor J., and Roger Hayter. 2005. No "Greek-letter writing": local models of resource economies. *Growth and Change* 36(4), pp. 453-470.
- Barnes, Trevor J., Roger Hayter, and Elizabeth Hay. 2001. Stormy weather: cyclones, Harold Innis, and Port Alberni, BC. *Environment and Planning A* 33(12), pp. 2127-2147.
- Becker, Karin L. 2016. The paradox of plenty: blessings and curses in the oil patch. In Kyle Conway, and William Caraher, Editors, 2016. *The Bakken Goes Boom*, Grand Forks: Digital Press at the University of North Dakota, pp. 11-30.
- Bridge, Gavin, and Philippe Le Billon. 2017. *Oil*. Second Edition. Malden: Polity Press.
- Cummings, Ronald G., and Arthur F. Mehr. 1977. Investments for urban infrastructure in boomtowns. *Natural Resources Journal* 17.
- Drache, Daniel. 1995. Celebrating Innis: the man, the legacy, and our future. In Harold A. Innis, and Daniel Drache, Editors, 1995. *Staples, Markets, and Cultural Change: Selected Essays*, Montreal: McGill-Queen's University Press, pp. xiii-lix.
- Drew, Joseph, Brian Edward Dollery, and Boyd Dirk Blackwell. 2018. A square deal? Mining costs, mining royalties and local government in New South Wales, Australia. *Resources Policy* 55, pp. 113-122.
- Enoch, Simon, and Emily Eaton. 2018. A prairie patchwork: reliance on oil industry philanthropy in Saskatchewan boom towns. Regina: Canadian Centre for Policy Alternatives, pp. 1-21.

- Fleming, David, Timothy Komarek, Mark Partridge, and Thomas Measham. 2015. The booming socioeconomic impacts of shale: a review of findings and methods in the empirical literature. Munich Personal RePEc Archive, 68487.
- Freudenburg, William R. 1992. Addictive economies: extractive industries and vulnerable localities in a changing world economy. *Rural Sociology* 57(3), pp. 305-332.
- Freudenburg, William R., and Robert Gramling. 1992. Community impacts of technological change: toward a longitudinal perspective. *Social Forces* 70, pp. 937-955.
- Furlong, Kathryn. 2019. Geographies of infrastructure 1: economies. *Progress in Human Geography*, advanced online publication.
<https://doi.org/10.1177%2F0309132519850913>
- Gilmore, John S. 1976. Boom towns may hinder energy resource development. *Science* 191(4227), pp. 535-540.
- Grubert, Emily. 2018. The Eagle Ford and Bakken shale regions of the United States: a comparative case study. *The Extractive Industries and Society*, 5(4), pp. 570-580.
- Haggerty, Julia, and Keegan McBride. 2016. Does local monitoring empower fracking host communities? A case study from the gas fields of Wyoming. *Journal of Rural Studies* 43, pp. 235-247.
- Haggerty, Julia H., Adrienne C. Kroepsch, Kathryn Bills Walsh, Kristin K. Smith, and David W. Bowen. 2018. Geographies of impact and the impacts of geography: unconventional oil and gas in the American West. *The Extractive Industries and Society* 5(4), pp. 619-633.
- Haggerty, Julia H., Kristin K. Smith, Jason Weigle, Timothy W. Kelsey, Kathryn Bills Walsh, Roger Coupal, et al. 2019. Tradeoffs, balancing, and adaptation in the agriculture-oil and gas nexus: insights from farmers and ranchers in the United States. *Energy Research & Social Science* 47, pp. 84-92.
- Haggerty, Mark N. 2012. Benefiting from unconventional oil: state fiscal policy is unprepared for the heightened community impacts of unconventional oil plays. *Headwaters Economics*. <https://headwaterseconomics.org/energy/oil-gas/unconventional-oil-and-north-dakota-communities/>
- Haggerty, Mark N., and Julia H. Haggerty. 2015. Energy development as opportunity and challenge in the rural West. In David Danbom, Editor, 2015. *The Rural West: Common Regional Issues*, Salt Lake City: University of Utah Press, pp. 161-190.

- Halseth, Greg. 2016. Introduction: political economy perspectives on the transformation of resource towns and peripheries. In Greg Halseth, Editor, 2016. *Transformation of Resource Towns and Peripheries*, New York: Routledge, pp. 1-10.
- Halseth, Greg, and Laura Ryser. 2017. *Towards a Political Economy of Resource-dependent Regions*. New York: Routledge.
- Hearne, Robert R., and Felix N. Fernando. 2016. Strategies for community and industry water management in the oil producing region of North Dakota. *Water* 8(8), 331.
- Horner, Robert M., Christopher B. Harto, Robert B. Jackson, Ella R. Lowry, Adam R. Brandt, T. W. Yeskoo, et al. 2016. Water use and management in the Bakken shale oil play in North Dakota. *Environmental Science & Technology* 50(6), pp. 3275-3282.
- Howe, Cymene, Jessica Lockrem, Hannah Appel, Edward Hackett, Dominic Boyer, Randal Hall, et al. 2016. Paradoxical infrastructures: ruins, retrofit, and risk. *Science, Technology, & Human Values* 41(3), pp. 547-565.
- Humphreys, Macartan, Jeffrey D. Sachs, and Joseph E. Stiglitz, Editors. 2007. *Escaping the Resource Curse*. New York: Columbia University Press.
- Jacquet, Jeffrey B. 2014. Review of risks to communities from shale energy development. *Environment Science & Technology* 48(15), pp. 8321-8333.
- Jacquet, Jeffrey B. 2015. The rise of ‘private participation’ in the planning of energy projects in the rural United States. *Society & Natural Resources* 28(3), pp. 231-245.
- Jacquet, Jeffrey B., and David L. Kay. 2014. “The unconventional boomtown: updating the impact model to fit new spatial and temporal scales. *Journal of Rural and Community Development* 9(1), pp. 1-23.
- Jacquet, Jeffrey B., Katherine Witt, William Rifkin, and Julia H. Haggerty. 2018a. A complex adaptive system or just a tangled mess? Property rights and shale gas governance in Australia and the US. In John Whitton, Matthew Cotton, Ioan M. Charnley-Parry, and Kathy Brasier, Editors, 2018. *Governing Shale Gas*, New York: Routledge, pp. 55-68.
- Jacquet, Jeffrey B., Anne N. Junod, Dylan Bugden, Grace Wildermuth, Joshua T. Fergen, Kirk Jalbert, et al. 2018b. A decade of Marcellus Shale: impacts to people, policy, and culture from 2008 to 2018 in the Greater Mid-Atlantic region of the United States. *The Extractive Industries and Society*, 5(4).

- Job Service North Dakota. 2019. Quarterly census of employment and wages (QCEW) for mining, quarrying, and oil and gas extraction. <https://www.ndworkforceintelligence.com>
- Junod, Anne N., Jeffrey B. Jacquet, Felix Fernando, and Lynette Flage. 2018. Life in the goldilocks zone: perceptions of place disruption on the periphery of the Bakken shale. *Society & Natural Resources* 31(2), pp. 200-217.
- Kinne, Beth. 2018. Regulating unconventional shale gas development in the United States: diverging priorities, overlapping jurisdictions, and asymmetrical data access. In John Whitton, Matthew Cotton, Ioan M. Charnley-Parry, and Kathy Brasier, Editors, 2018. *Governing Shale Gas*, New York: Routledge, pp. 23-50.
- Kurz, Bethany A., Daniel J. Stepan, Kyle A. Glazewski, Bradley G. Stevens, Thomas E. Doll, Justin T. Kovacevich, et al. 2016. A review of Bakken water management practices and potential outlook. University of North Dakota Energy and Environmental Research Center.
- Kusnetz, Nicholas. 2012. The Bakken oil play spurs a booming business – in water. *High Country News*. August 6, 2012. <https://www.hcn.org/issues/44.13/the-bakken-oil-play-spurs-a-booming-business-in-water>
- Lin, Zhulu, Tong Lin, Siew Hoon Lim, Michael H. Hove, and William M. Schuh. 2018. Impacts of Bakken shale oil development on regional water uses and supply. *Journal of the American Water Resources Association* 54(1), pp. 225-239.
- Lindlof, Thomas R., and Bryan C. Taylor. 2011. *Qualitative Communication Research Methods*. Thousand Oaks: Sage.
- Luke, Hanabeth, Martin Brueckner, and Nia Emmanouil. 2018. Unconventional gas development in Australia: a critical review of its social license. *The Extractive Industries and Society* 5(4), pp. 648-662.
- Malin, Stephanie A., and Kathryn Teigen DeMaster. 2016. A devil's bargain: rural environmental injustices and hydraulic fracturing on Pennsylvania's farms. *Journal of Rural Studies* 47, pp. 278-290.
- Markey, Sean, Greg Halseth, Laura Ryser, Neil Argent, and Jonathan Boron. 2019. Bending the arc of the staples trap: negotiating rural resource revenues in an age of policy incoherence. *Journal of Rural Studies* 67, pp. 25-36.
- Mayer, Adam, Shawn K. Olson-Hazboun, and Stephanie Malin. 2018. Fracking fortunes: economic well-being and oil and gas development along the urban-rural continuum. *Rural Sociology* 83(3), pp. 532-567.

- Measham, Thomas G., David A. Fleming, and Heinz Schandl. 2016. A conceptual model of the socioeconomic impacts of unconventional fossil fuel extraction. *Global Environmental Change* 36, pp. 101-110.
- Murphy, Trey, Christian Brannstrom, Matthew Fry, and Michael Ewers. 2018. Economic-development stakeholder perspectives on boomtown dynamics in the Eagle Ford shale, Texas. *Geographical Review* 108(1), pp. 24-44.
- National Council for Public-Private Partnerships (NCPPP). N.d. Seven keys to success. <https://www.ncppp.org/ppp-basics/7-keys/>
- Newell, Richard G., and Daniel Raimi. 2015. Oil and gas revenue allocations to local governments in eight states. National Bureau of Economic Research, Working Paper 21615.
- Newell, Richard G., and Daniel Raimi. 2018. The fiscal impacts of increased US oil and gas development on local governments. *Energy Policy* 117, pp. 14-24.
- North Dakota State Water Commission. 2015. North Dakota 2015 state water management plan. <http://www.swc.nd.gov>
- North Dakota State Water Commission. 2017. Water development report: an update to the 2015 state water plan. http://www.swc.state.nd.us/info_edu/state_water_plan/archives/pdfs/2017_2019_Water_Development_Report.pdf
- Rabe, Barry G. 2014. Shale play politics: the intergovernmental odyssey of American shale governance. *Environmental Science & Technology* 48(15), pp. 8369-8375.
- Raimi, Daniel. 2018. *The Fracking Debate: The Risks, Benefits, and Uncertainties of the Shale Revolution*. New York: Columbia University Press.
- Ross, Michael L. 1999. The political economy of the resource curse. *World Politics* 51(2), pp. 297-322.
- Ryser, Laura, Greg Halseth, Sean Markey, Cameron Gunton, and Neil Argent. 2019. Path dependency or investing in place: understanding the changing conditions for rural resource regions. *The Extractive Industries and Society* 6(1), pp. 29-40.
- Sachs, Jeffrey D., and Andrew M. Warner. 2001. The curse of natural resources. *European Economic Review* 45(4-6), pp. 827-838.
- Schafft, Kai A., Kathryn Brasier, and Arielle Hesse. 2018. Reconceptualizing rapid energy resource development and its impacts: thinking regionally, spatially and intersectionally. *Journal of Rural Studies* 68, pp. 296-305.

- Scheyder, Ernest. 2013. Insight: the fight for North Dakota's fracking-water market. Reuters, May 20, 2013. <https://in.reuters.com/article/us-water-bakken-insight/insight-the-fight-for-north-dakotas-fracking-water-market-idUSBRE94J02120130520>
- Silva, Tony J., and Jessica A. Crowe. 2015. The hope-reality gap: rural community officials' perceptions of unconventional shale development as a means to increase local population and revitalize resource extraction. *Community Development* 46(4), pp. 312-328.
- Small, Mitchell J., Paul C. Stern, Elizabeth Bomberg, Susan M. Christopherson, Bernard D. Goldstein, Andrei L. Israel, et al. 2014. Risks and risk governance in unconventional shale gas development. *Environmental Science & Technology*, 48(15), pp. 8289-8297.
- Smith, Kristin K., and Julia H. Haggerty. 2018. Devolved governance & alternative dispute resolution programs: an example from the Bakken. In John Whitton, Matthew Cotton, Ioan M. Charnley-Parry, and Kathy Brasier, Editors, 2018. *Governing Shale Gas*, New York: Routledge, pp. 184-197.
- Smith, Kristin K., Julia H. Haggerty, David L. Kay, and Roger Coupal. 2019. Using shared services to mitigate boomtown impacts in the Bakken shale play: resourcefulness or over-adaptation?. *Journal of Rural and Community Development* 14(2).
- Smith, Nick. 2013. Water project compromise 'manageable.' Bismarck Tribune, May 17, 2013. https://bismarcktribune.com/bakken/water-project-compromise-manageable/article_c809d160-bf30-11e2-b944-001a4bcf887a.html
- Stantec Consulting Services, Inc. 2018. Industrial water supply infrastructure: financial analysis of the Western Area Water Supply Authority. https://www.legis.nd.gov/files/committees/65-2017/19_5129_03000appendixl.pdf
- Stedman, Richard C., John R. Parkins, and Thomas M. Beckley. 2004. Resource dependence and community well-being in rural Canada. *Rural Sociology* 69(2), pp. 213-234.
- Theodori, Gene L. 2018. Shale energy development in the Southern United States: a review of perceived and objective social impacts. *The Extractive Industries and Society* 5(4).
- Tolbert, Charles M. 2006. Sustainable community in oil and gas country: final report. U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2006-011.

- Tonts, Matthew, Kirsten Martinus, and Paul Plummer. 2013. Regional development, redistribution and the extraction of mineral resources: the Western Australian Goldfields as a resource bank. *Applied Geography* 45, pp. 365-374.
- Tonts, Matthew, Paul Plummer, and Misty Lawrie. 2012. Socio-economic wellbeing in Australian mining towns: a comparative analysis. *Journal of Rural Studies* 28(3), pp. 288-301.
- Walker, Richard A. 2001. California's golden road to riches: natural resources and regional capitalism, 1848–1940. *Annals of the Association of American Geographers* 91(1), pp. 167-199.
- Wallerstein, Immanuel Maurice. 2004. *World-systems Analysis: An Introduction*. Durham: Duke University Press.
- Walsh, Katie B., and Julia H. Haggerty. 2019. I'd do it again in a heartbeat: coalbed methane development and satisfied surface owners in Sheridan County, Wyoming. *The Extractive Industries and Society* 6(1), pp. 85-93.
- Watts, Michael. 2004. Resource curse? Governmentality, oil and power in the Niger Delta, Nigeria. *Geopolitics* 9(1), pp. 50-80.
- Western Area Water Supply Project (WAWS). 2018. 2019-2021 Legislative request: \$50M. Accessed May 4, 2019. <http://wawsp.com/news-events/buzz-3rd-quarter-2018/2019-2021-legislative-request-50m/>
- Western Area Water Supply Project (WAWS). 2019. 2019 Legislative progress report. Accessed May 4, 2019. <http://wawsp.com/news-events/1st-quarter-buzz/2019-legislative-progress-report/>
- Wilson, Ceit Elizabeth, Tiffany H. Morrison, J-A. Everingham, and John McCarthy. 2017. Steering social outcomes in America's energy heartland: state and private meta-governance in the Marcellus shale, Pennsylvania. *American Review of Public Administration* 47(8), pp. 929-944.
- Witt, Katherine, John Whitton, and Will Rifkin. 2018. Is the gas industry a good neighbour? A comparison of UK and Australia experiences in terms of procedural fairness and distributive justice. *The Extractive Industries and Society* 5(4), pp. 547-556.
- Zirogiannis, Nikolaos, Jessica Alcorn, John Rupp, Sanya Carley, and John D. Graham. 2016. State regulation of unconventional gas development in the US: an empirical evaluation. *Energy Research & Social Science* 11, pp. 142-154.

CHAPTER SEVEN

HOW ENERGY COMMUNITIES SUBSIDIZE INDUSTRY: ROAD
INFRASTRUCTURE INVESTMENTS IN THE BAKKEN SHALE FORMATION, U.S.

Contribution of Authors and Co-Authors

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Contributions: Kristin Smith developed the research question and approach. She collected and analyzed the data for the research, and she wrote the manuscript.

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Contributions: Julia Haggerty supervised the project, offering feedback on the research's development and findings. She also edited the manuscript.

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Introduction

Roads in boomtowns are simultaneously mundane and spectacle. A drive down County Road 10 in McKenzie County, North Dakota can be easily dismissed as an everyday experience. However, the history (and future) of this \$100 million road – dubbed the Northern Bypass – offers a glimpse into the complicated and often stunning infrastructure decisions that the public sector must make to accommodate unconventional oil and gas development (UOG).

The Northern Bypass is located in the heart of the Bakken, a region in the northern Great Plains, United States, that experienced rapid growth in UOG development from 2009 to 2014. Prior to the UOG boom, the Bypass was a hodgepodge of gravel and section roads of varying quality that were loosely connected through a series of right- and left-hand turns. Today, it is a paved, highly engineered road designed to move heavy industrial traffic into and away from the core of the oil fields. Notably, this investment has long-term implications: from re-working traffic flows in McKenzie County and improving traffic safety to increasing the county's annual public works budget indefinitely. The Northern Bypass demonstrates the demands on and of roads in regions with UOG.

UOG development requires a massive amount of public sector coordination and investment at the local level. North Dakota's boom in UOG prompted a surge in the state's annual oil production – from 62 million barrels in 2008 to 466 million barrels just ten years later (North Dakota Oil and Gas Division n.d.). As communities attempted to accommodate the rapid influx of workers and demands on government services, they

made extensive public infrastructure investments to water and wastewater, telecommunications, emergency and safety, and transportation systems. For reference, the Northern Bypass is not unique in the Bakken. It is just 40 miles of the 1,886 miles of new state, county, and local roads that were built from 2009 to 2017 as a result of the boom in UOG.

Public infrastructure investments comprise one of the fundamental ways that the region has changed due to UOG development and yet the extent of these changes, as well as their long-term opportunities and risks, are not well understood. Further, UOG development's impacts are distributed unevenly within regions, but the multi- and inter-scalar consequences to governments are unclear. This study addresses these gaps while contributing to ongoing debates about the distribution of benefits and costs in communities that host UOG. Specifically, this research poses two questions:

RQ 1: How did UOG development change the region's road infrastructure and systems?

RQ 2: What are the range of strategies that different scales of government employed to mitigate the impacts of UOG development on the road system?

The Overlooked Role of Roads in Resource and Energy Geographies

Cost Shifting, in the Short- and Long-term, Is a Defining Feature of Resource Communities

Resource and energy geographers have long grappled with questions about whether the benefits of resource extraction outweigh the costs in host communities (for UOG assessments, see, e.g., Junod et al. 2018; Kim and Johnson 2020; Walsh and Haggerty 2019). Resources are distributed unevenly from a material perspective, and

which stakeholders are able to profit from their extraction and distribution are similarly uneven (Bridge 2009). At the macroeconomic level, the resource curse and natural resource dependence literatures investigate how exported profits, corruption, and poorly resourced institutions can lead countries with resource abundance to have poor economic development outcomes (e.g., Humphreys et al. 2007; Ross 1999; Sachs and Warner 1995). Critical resource geographers, including those within the field of political ecology, emphasize the importance of questions related to resource access and allocation, such as how resources are enclosed and privatized, who has the power to access and exploit resources, and who controls the means of their production (e.g., Bridge 2018; Walker 2001; Watts 2004). By questioning assumptions that resources translate into economic benefits, these bodies of scholarship emphasize the contested, political nature of resource development and extraction.

Externalities, including cost-shifting, are key concerns within resource geography (Hayter and Patchell 2015; Solomon, Pasqualetti, and Luchsinger 2004). Bridge (2009, 1231) defines cost-shifting as the processes and frameworks by which unaccounted environmental and social costs are “reallocated across space and time.” As a result of cost-shifting, resource prices do not account for the full suite of environmental and social costs associated with its extraction, distribution, and consumption. While some of these costs are highly visible (oil spills, for instance), there are other externalities related to resource development and extraction more hidden from view, from traffic accidents to air pollutants (Bridge and Le Billon 2017). These costs often go unaccounted for, though they can represent significant burdens, particularly at the local level.

The uneven allocation of costs and benefits associated with resource development can entrench problematic core-periphery economic relationships. Although resource peripheries are often portrayed as “old-fashioned” economies, they are critical to global capitalist accumulation processes and thus offer insights into the relationships between local places and globalization, financialization, and restructuring (Barnes and Christophers 2018; Hayter, Barnes, and Bradshaw 2003). By definition, resource peripheries are remote and relational. They typically absorb the costs of resource development while exporting the benefits to core geographies of the capitalist system (Drache 1995; Wallerstein 2004). Due to their reliance on external markets, peripheries are exposed to heightened market volatility – what has been described within staples theory as stormy cyclones of investment and disinvestment (Barnes, Hayter, and Hay 2001). Decisionmakers within resource peripheries typically acknowledge the risk of resource dependence but have limited options to create economic diversification due to structural constraints, such as remote economic geographies and unequal power relationships between municipalities and large multi- or transnational extraction companies (Freudenberg 1992; Smith and Haggerty 2020).

In this context, the multi-scalar dimensions of government decisions and investments, including upfront and long-term maintenance costs associated with infrastructure, are of key concern within resource peripheries. Economic benefits of resource extraction accrued at the macroeconomic scale may have different cost-benefit distributions at the microeconomic scale. Communities can become “over-adapted” to industry’s needs as their institutions, culture and practices, educational systems, and

infrastructure co-evolve with and become specialized to industry (Freudenburg 1992). At the local level, public and private sectors in resource peripheries typically make significant capital investments into transportation and distribution infrastructure to enable and facilitate industrial development (Drache 1995; Haggerty et al. 2018). While these infrastructure investments are made with the assumption that they will mutually benefit the public and industry, they can become financial burdens to local governments if industry leaves (Freudenburg 1992; Drache 1995; Smith and Haggerty 2020). For instance, Drew, Dollery, and Blackwell (2018) found that the additional operational costs imposed on local governments by mining in New South Wales, Australia outweighed the mining-related tax revenues they received from the state government. When communities over-adapt to industry their investments, sunk costs (fiscal and temporal) and opportunity costs create path dependencies that make it harder to diversify away from resource extraction, even if community members are interested in economic transformation (Smith 2020; Wilson 2012).

The problem of communities over-accommodating and/or over-specializing their infrastructure is a noted dilemma within resource geography (e.g., Connelly and Nel 2016; Freudenburg 1992; Hayter and Patchell 2015). Yet, policy solutions have not emerged, leaving communities to “reinvent the wheel” each time resource development occurs in a new geography. If the goal of community leaders and elected officials in resource peripheries is to create long-term benefits for communities from resource extraction, the ways in which their accommodation of industry shape socioeconomic

outcomes – including how cost shifting occurs between and amongst private and public sectors – need to be taken into account.

Socioeconomic Impacts of UOG in the United States

In the early 2000s, high oil prices aligned with improvements in engineering technologies – including hydraulic fracturing and horizontal drilling – to make UOG extraction economically viable in new geographies. UOG development refers to the extraction of crude oil and natural gas in low-permeability sandstones, gas shales, and coalbed methane that require a different set of drilling technologies from “conventional” methods (Wagener 2018). UOG resulted in a boom in onshore oil production in the United States and also prompted significant economic and geopolitical shifts in global markets (McNally 2017; O’Sullivan 2017). While the boom began with historically high oil prices of over \$100/barrel, UOG development slowed at the end of 2014 when prices plummeted to below \$30/barrel. The market remained volatile between 2014 and 2020, though oil production in North Dakota steadily increased during this period (North Dakota Oil and Gas Division n.d.). In 2020, oil prices crashed to new record lows – at one-point trading at negative numbers – due to impacts from COVID-19 and the global oversupply of oil (Clark, Lee, and Anchondo 2020). For communities that host oil development, the volatility and then collapse of the oil market created significant fiscal hardship and uncertainty.

Resource peripheries that host UOG have distinct historic, economic, cultural, and subterranean characteristics (Haggerty et al. 2018). UOG development targets homogenous shale layers that enable and require more dispersed drilling across the

landscape (Cameron and Stanley 2017). Consequently, UOG development is more labor, infrastructure, and capital intensive (Dybing 2012; Murphy et al. 2018). Regions with UOG often host hundreds of oil-field service companies, contractors, and sub-contractors, which are constantly being bought and sold, consolidated and broken apart (Bridge and Le Billon 2017; Small et al. 2014). The UOG industry is highly dynamic and competitive, incentivizing constant and urgent searches for efficiency improvements and an overall sense of secrecy about future development plans (Appel, Mason, and Watts 2015; Cameron and Stanley 2017). In the short term, UOG generally prompts short-term economic benefits from job creation and increases in tax revenues (Raimi 2017).

However, UOG also creates incidental costs, including higher land and labor costs (Barth 2013; Chambers 2020), impacts to quality of life (Mayer 2017), increases in government operations (Olien and Olien 1982), and reclamation problems (Smith and Haggerty 2018), to name a few. The variables that make UOG distinct – its regional nature and rapid pace, the uncertainty of future oil prices, the complex business makeup of industry, including its lack of transparency – create significant challenges for local governments as they attempt to address energy impacts and capture long-term benefits (Jacquet 2014; Measham, Fleming, Schandl 2016; Smith 2020).

There is surprisingly limited research on the *capacity* of local governments to address the burdens of UOG development on public infrastructure and government services (Buse et al. 2019). There are no formal models for helping local governments plan for and address rapid growth associated with UOG (Keough 2015), and rural governments are especially challenged when it comes to managing impacts (Krupnick,

Echarte, and Muehlenbachs 2017). Given these challenges, Brasier et al. (2014) recommend investing in local capacity by supporting regional planning collaborations, streamlining coordination between governments and organizations, and increasing availability of planning and technical staff. In some geographies, municipal and county governments have tried to regulate UOG, though their capacity to do so varies and, at times, state governments have preempted their regulatory attempts (e.g., Goodman, Hatch, and McDonald 2020; Mayer and Malin 2018; Ryder 2017). Although rural resource communities can be highly innovative at problem solving, they often cannot address the full suite of impacts associated with UOG due to the scale of development (Smith et al. 2019; Smith and Haggerty 2020). This leads to deferred maintenance, housing and labor shortages, high municipal debt loads, and other costs that may constrain their long-term ability to leverage resource development into long-term prosperity.

Road Infrastructure and UOG Impacts

This research seeks to engage critically with the infrastructural outcomes of UOG development in resource peripheries and thus draws upon the broader “infrastructure turn” in the humanities and social science literatures (Howe et al. 2016). Infrastructures are frequently assumed to be objective, permanent, and stable but in practice are inherently political, contingent, and demanding of constant maintenance (Carse 2014; Carse and Lewis 2017; Howe et al. 2016). Notably, infrastructures’ costs are often justified with promises of economic development and increased wellbeing (Kaika 2005; Meehan 2014) but can create unintended risks and/or undesired change (Appel, Anand,

and Gupta 2018; Harvey and Knox 2015). Researching infrastructure draws attention to processes that are “characterized both by path dependencies and by rupture” as Haarstad and Wanvik (2017) point out in their conceptualization of “carbonscapes.” Infrastructure simultaneously creates regeneration and degeneration, connections and disconnections, solutions and problems (Carse 2014; Howe et al. 2016). The humanities and social science literatures foreground infrastructure’s instabilities and incoherencies as a framework for questioning investments that are often taken for granted, analyzing opportunity costs, and suggesting alternative paths for transformation.

Roads also reflect the paradoxical nature of infrastructure: roads are at once standardized, engineered, and technical and yet contested, demanding of continual maintenance, and highly specific to their geography (Harvey and Knox 2015). Roads in the United States have complex jurisdictional governance and funding systems, a product of the country’s fiscal federalism (Petroski 2016). There are long-standing debates over which government entities should fund and manage the construction and maintenance of roads. Competing arguments between decentralized versus centralized governance and general-tax financing versus user-fee financing manifest themselves into uneasy tensions at the local level, in which decisionmakers often rely on federal funding for construction projects but simultaneously value local control (Glaeser 2016; Oates 1972).

If energy infrastructures are key components of the regulatory practices, technologies, and local context that are assembled to support industry’s aims (Bouzarovski, Bradshaw, and Wochnik 2015), then roads should be seen as vital components of UOG development. However, to date, the UOG impacts research about

roads has predominantly focused on traffic accidents (e.g., Graham et al. 2015) and community frustrations (e.g., Mayer 2017; Schafft et al. 2014). Less attention has been given to how roads are changed by UOG and how local and state governments manage impacts. Exceptions include Murphy et al.'s (2018) research, which identified how Texas governments in the Eagle Ford Shale Play struggled with lags between drilling impacts and receiving funds to address them. Additionally, Krupnick, Echarte, and Muehlenbachs (2017) argued that while impacts to roads are high in communities that host UOG, most local governments are able to meet the increased demands on their infrastructure. However, they specifically identified the Bakken as a region where costs may outweigh the benefits. Within energy geography, there have been calls to follow the supply chain of oil through networks of distribution and processing (e.g., Huber 2017), but the role of public infrastructure in regions of extraction has largely been overlooked.

Methods

This research employed a mixed methods approach, including (1) semi-structured interviews, (2) a survey of township officials, (3) document analysis of policies, transportation reports, and traffic counts, and (4) participant observations. The research focuses on four counties in North Dakota's Bakken Shale Formation: McKenzie County, Mountrail County, William County, and Dunn County (Table 7.1). These four counties constitute the "core" of the Bakken, accounting for 92% of the state's entire annual oil production (North Dakota Oil and Gas Division n.d.). Additional data were collected from non-core counties to provide points of comparison. Collectively, the data were used to investigate how the UOG boom challenged and changed the Bakken's road

infrastructure, how governments responded, and the long-term impacts of these infrastructural decisions.

Table 7.1. Geographic scope of the research: North Dakota’s “Big 4” oil-producing counties.

County	Producing Wells, 2018 ¹	Total Barrels of Oil, 2019 ²	Acres ³	Population, 2018 ⁴	Paved Roads 2010 ⁵ vs 2020 ⁶
McKenzie	3,963	201,571,137	1,830,989	13,632	137 / 213
Mountrail	2,672	90,342,120	1,242,589	10,218	unknown / 152
Williams	2,392	89,720,768	1,374,808	35,350	170 / 288
Dunn	1,975	106,446,214	1,332,507	4,332	16 / 56

¹Svihovec 2018; ²North Dakota Oil and Gas Division n.d.; ³U.S. Geological Survey 2018; ⁴U.S. Department of Commerce 2019; ⁵Berwick et al. 2010; ⁶Dybing et. al 2020.

Thirty-six semi-structured interviews were conducted with decision makers to understand road-related impacts at the state, county, and local scales, as summarized by Table 7.1. Interviewees were recruited from throughout western North Dakota and eastern Montana, representing a range of experiences with UOG development. Interviews were conducted during a series of research trips in 2018, 2019, and 2020. Interviews were recorded, transcribed, and then coded using Nvivo code-and-retrieve software. Initial interviews with township officials revealed highly variable experiences with UOG, and a follow-up survey was conducted to better understand the township experience. The survey was sent to township chairpersons in every township in McKenzie, Williams, and Mountrail Counties. ^[1] Forty-four of the 115 township surveys sent out were returned, representing a 38% response rate.

Table 7.2. Summary of interviewees by governance scale.

Interviews by geography and decision-making scale	Number
North Dakota Department of Transportation (NDDOT) Employees	4
County Officials, Public Works Employees, and Engineers	11
Cities and Township Elected Officials and Employees	8
North Dakota and Montana Regional Transportation Engineers and Experts	8
Eastern Montana Government Employees and Engineers	5
Total	36

Additionally, extensive document analyses were conducted to understand the state-level debates surrounding transportation infrastructure funding. The author analyzed the testimonies associated with two bills that allocated significant state funds to road projects (2013 SB 2176; 2015 SB 2103). Related to these funding bills, the Upper Great Plains Transportation Institute was tasked by the North Dakota Legislative Assembly with assessing local and county infrastructure needs to assist with the state's funding prioritization. These reports came out in 2010, 2012, 2014, 2016, and 2020. Additional data included township mileage charts, overweight permit trends collected by the Western Dakota Energy Association, and traffic and accident counts.

Finally, the author spent over 150 days in the field conducting research over five years in the Bakken, 2016 – 2020. Between 2018 and 2020 the author attended multiple state and community meetings related to roads and infrastructure issues, as well as the following roads-related conferences: the 2018 Western Dakota Energy Association Annual Meeting, the 2019 Empower North Dakota Energy Conference, the 2019

National Transportation in Indian Country Conference, and the 2019 Ports-to-Plains Annual Conference.

Due to the rural nature of the Bakken, the first author drove an estimated 13,000+ miles for field research over five years. The researcher came to understand the driving times between interviews and meetings as important experiences contributing to the understanding of this project. The author learned to read roads and vehicles for UOG impacts: expanded road shoulders and new turning lanes were clear indicators that roads were being used for UOG, as well as over-turned trucks, pieces of metal and other objects that fall off truck beds, rutted roads, cracked windshields, and dust, to name a few. Many of these experiences were recorded in the author's field notes, but in the later years of the project the author also narrated and recorded the experiences of driving roads in the Bakken.

The study's research design responds to Bridge's (2018) call to think about energy spatiality with the goal of "[identifying] processes at work that are largely invisible to dominant analytical frameworks" (Bridge 2018). The data were analyzed drawing upon energy geography's tradition of understanding energy impacts as social, political, economic, and multi-scalar in nature (Calvert 2016; Zimmer 2011). Collectively, the qualitative and quantitative data speak to how UOG development required different road infrastructure, and how decisions were made at the state, county, and local government scales to address and accommodate that need.

Part 1. North Dakota, Its Roads, and UOG Impacts

North Dakota is remote and vast, making its extensive road infrastructure critical for social and economic connectivity, complex from a governance perspective, and expensive to maintain. At the state scale, the North Dakota Department of Transportation (NDDOT) is the government agency responsible for the State Highway System (7,414 miles) and Interstate roads (1,142 miles including both lanes) (NDDOT 2019a, 2019b). The NDDOT has eight district offices, each of which is responsible for its own construction, maintenance, mowing, and snow removal. At the local scale, county, city, and township governments play an outsized role in managing UOG impacts to roads since many wells are in remote locations (Tolliver and Dybing 2010; Dybing 2012). North Dakota has the highest number of local governments per capita in the U.S. (Maciag 2012), including 52 county governments, 1,314 township governments, and 357 city governments (North Dakota 2020). Each of these entities is tasked with constructing and maintaining the road infrastructure within their jurisdictional boundaries. County governments are also responsible for roads in unorganized townships.^[2] While road networks often feel cohesive to drivers, their governance structures are highly fragmented.

Funding sources for road construction and maintenance are also fragmented and often unpredictable, a trend amplified by UOG development. North Dakota has the highest road costs per capita in the U.S. (Urban Institute 2020), demonstrating Kraenzel's (1955) "social cost of space" in the Great Plains. Like most states, the NDDOT's budget is heavily dependent on the Federal Highway Trust Fund,^[3] accounting for an average of

over 51% of NDDOT's revenues from 2012 to 2017 (not including one-time legislative funding transfers) (UGPTI and NDDOT 2018). County governments fund their roads through a suite of taxes, primarily mill levies (property tax), state highway tax distribution fund, gross production tax, and the county share of the federal fuel tax (Dybing 2018). Cities and townships predominantly rely on mill levies and special assessment districts to fund annual transportation maintenance and improvement costs. From the state to the local scale, transportation needs are typically greater than available funding, and thus decisionmakers must constantly compromise between ideal infrastructure investments and sufficient levels of investment.

Five federally recognized tribes reside within North Dakota's political boundaries: (1) the Mandan, Hidatsa, and Arikara Nation, (2) the Spirit Lake Nation, (3) the Standing Rock Sioux, (4) the Turtle Mountain Band of Chippewa Indians, and (5) the Sisseton-Wahpeton Oyate Nation. Tribal roads are mediated through the Bureau of Indian Affairs (BIA), though recent legislation now allows for sovereign departments of transportation. A 2012 UGPTI report noted that two thirds of North Dakota's tribal government and BIA roads in their study were in poor condition (Tolliver et al. 2012), suggesting the uneven impacts that can occur to regional road infrastructure due to historic, socio-economic, and governance differences. Since tribal roads have separate governance structures and funding mechanisms, they are not included in this research.

UOG Impacts on Road Infrastructure

The impacts from UOG development on road infrastructure are hard to overestimate. Traffic associated with UOG development is industrial, heavy, and

constant. Oil field traffic operates year-round and around the clock. The Upper Great Plains Transportation Institute (Dybing et al. 2020) estimates that each well in the Bakken requires 3,520 truck loads (a total of in- and out-bound trips) to drill and hydraulically fracture: more than half of these trucks carry freshwater in or processed water out (unless there is pipeline access), and the rest of the loads are attributed to sand, chemicals, drilling mud, cement, gravel or scoria, fuel, frac and cement pumper trucks, rig equipment, frac tanks, pipes, and workover rigs. One truck does as much damage as 9,600 cars and overloaded trucks can do as much damage as 19,000 cars (UGPTI 2013). Between 2005 and 2017 truck traffic increased on NDDOT roads by 66%, resulting in significant damage to the roads, time-consuming traffic jams, and a number of safety concerns (NDDOT 2019b). One county engineer explained, “Some of our roads... went from having three trucks on it in a month to 800 trucks a day.” State and local governments throughout the region struggled to keep up with the pace and scale of UOG, and the state’s historic disinvestment in transportation infrastructure in western North Dakota compounded the issues.

UOG development is rapid and dispersed across the landscape, implicating many previously neglected roads into industry’s assemblage. Although UOG stakeholders knew their drilling would have significant impacts on the roads, it was not required – nor was it common practice – to keep state, county, or local governments apprised of their development plans. As one NDDOT employee described the impacts, “It’s such a fluid industry with where they’re moving to. The whole area is busy, but they concentrate in different areas. And they’re changing their technology all the time, so things change with

that.” District offices were not regularly in touch with industry and were thus taken off guard when industry moved into new areas. This occurred at the local level as well. One county employee explained, “Oil companies are very secretive about their plans... They’re trying to hide from other companies, not from us. But they won’t share with us either.” Decision makers from all levels of government, from the NDDOT to the township level, identified the uncoordinated nature of the UOG industry and lack of communication as major challenges. Further, traditional road planning tools could not be used because historical traffic patterns became irrelevant, and the industry’s development patterns had too much spatial and temporal uncertainty (Dybing 2012; Tolliver 2014).

Consequently, governments had to make best guesses about how to prioritize road projects. When asked what strategies they used to manage impacts, one engineer replied,

It’s funny that you think we had a strategy. We were in pure reaction mode. As an engineer, I hate to admit it, but we couldn’t plan for next year or next month. We couldn’t plan for this afternoon. We oftentimes referred to it as, ‘Yeah, you had a plan at 7:00 AM when you got to work, and by 7:15, you’re on iteration seven.’ Things were changing that often.

Another engineer admitted, “Everybody usually says the oil field was running wild, but so was the county.” Not every solution worked out. NDDOT employees identified the 7.8-mile Dickinson bypass and the 3.9-mile Killdeer bypass as investments that were not cost effective in the long run. By the time these roads were constructed and ready for traffic, the industry had moved to new locations. These bypasses were expensive to build, \$33 million and \$30 million respectively (City of Dickinson 2013; NDDOT 2016), and represent large opportunity costs since they are underutilized. The uncoordinated and secretive nature of industry created logistical and planning challenges for state and local officials and employees who often found it impossible to stay on top of UOG impacts.

Responses to UOG Impacts

When the boom in UOG began, the impacts to road infrastructure forced state and local governments to rapidly adapt to the changing demands on and of roads while addressing safety and community concerns. This included significant investments in maintenance, building new roads, and improving existing roads by widening, resurfacing and strengthening pavement, and adding safety features. The NDDOT had its largest ever construction season during the 2013 – 2015 biennium, with more than \$1.6 billion being invested in roads throughout the state, most of which was focused on the Bakken (NDDOT 2019b). One NDDOT employee explained, while pointing at a road map of the Williston District, “Everything has been rebuilt. It’s easier for me to show you what hasn’t been rebuilt.” The largest projects included widening 34 miles of Highway 85, building the Lewis and Clark Bridge south of Williston (connecting the region’s two largest oil service hubs), and six new truck reliever routes around cities (NDDOT 2017).

At the local level, the pressures from UOG development created an opportunity to reimagine governance structures and rethink road networks. Counties hired new employees to address impacts and created new public works departments. As one city employee noted, “When I started [before the boom] there was four, I guess 5 employees, counting myself. And, at the peak we had 27. We’re back down to 15 now.” Labor shortages in the region prompted local governments to use national headhunters to recruit employees, and as a result the region benefitted from in-flows of new ideas and transportation expertise. Similar to NDDOT, local governments also made historically large investments into its road system. Between 2010 and 2017, the “Big Four” counties

collectively spent \$987 million on constructing, upgrading, and maintaining the region's county road system (Svihovec 2018).

UOG changed how roads were funded in the Bakken as state investments became larger and more common. Between 2008 and 2018, oil and gas extraction and production taxes raised over \$18 billion in the state, approximately 44% of its total tax revenues for these years (Bogart 2019). North Dakota redistributes a portion of oil and gas tax revenues to impacted counties, cities, and townships, as well as non-oil impacted geographies, through a complex formula that is regularly challenged and recalculated at the statehouse.^[4] Some counties received additional revenue from mineral royalties they own. One county engineer noted, "Our [road and bridge] budget went from \$2 million in the past...to \$74 million." While local governments were able to reinvest these revenues into their road infrastructure, the costs associated with UOG were also large. For instance, another county engineer recounted, "One [gravel] road...in peak time we were spending \$35,000 per week, per mile maintaining it. Putting out little fires, potholes, whatever. Keep adding gravel. Truck traffic was so heavy." Estimates of the impacts of UOG on roads range enormously, from \$23,000 per well in Pennsylvania (Abramzon et al. 2014) to \$133,000 in Texas (Naismith Engineering 2015). While the public benefited from local investments in transportation infrastructure and capacity, they also absorbed the costs of having to maintain and improve a road system that was relentlessly being damaged by UOG traffic.

The result of the massive investment in roads is that the region's state, county, and local road network has been redesigned to meet the needs of a future dominated by

UOG. Roads have been built and rebuilt to withstand far heavier loads, with many able to accommodate trucks weighing 105,500 pounds or more. Local governments collaborate on a regional overweight permit system, called LoadPass, to collect fees and govern the (many) trucks that are far heavier than this limit. Notably, interviewees did not think overweight permits typically covered the damages inflicted on roads from overweight trucks, a finding corroborated by other studies (e.g., Krupnick, Echarte, and Muehlenbachs 2017). Counties have become more strategic with their infrastructure, identifying roads to act as main arteries and targeting these roads for improvements. Further, the quality of data collected on the region's roads has vastly improved. Whereas in 2010 a comprehensive library of county road traffic counts did not exist, there are now data on every county road (e.g., Dybing et al. 2020). Much of this information has been collected by UGPTI and is publicly accessible through their online Geographic Roadway Inventory Tool (GRIT). The industrialization of the region's road network was a logistical and governance feat, but it also created new challenges, as will be discussed in the next section.

Part 2: Cost Shifting and Re-shifting to Manage UOG Impacts

The UOG industry is adept at shifting its costs onto the public. In turn, the industry's uneven costs and benefits (compounded by the industry's secrecy) prompted local and state governments to manage impacts by shifting their costs through time, space, and labor. The uneven costs and benefits are particularly apparent with regards to roads. For instance, one township official noted, "We have about \$1 million in our bank account, and we can't spend it. But that's also because we've been forcing oil companies

to keep up our roads.” In contrast, of the 44 township officials who responded to the survey, 25% of them indicated that their township did not have sufficient funds for their current needs. Additionally, 32% of respondents were not confident that they would have sufficient funds for the future. While North Dakota redistributes oil and gas tax revenues to local governments, the formula is not dependent on local context, resulting in some governments getting larger distributions of revenues than needed and other places receiving insufficient funds.

Cost Shifting through Time: From Disinvestment to Overinvestment

Shifting costs to the future, such as through deferring maintenance, is a tactic that North Dakota’s state and local governments have long used to manage budget shortfalls. In the decades leading up to the UOG boom, road upgrades and maintenance were often deferred in North Dakota, creating a legacy of disinvestment (NDDOT 2014). The 2012 UGPTI report described county roads as “[reflecting] budgetary limitations that have largely resulted in thin overlays as a means of improving the most miles of road with a limited amount of funds” (Tolliver et al. 2012). Deferred maintenance meant that when the boom began, road engineers had to address boom impacts that were compounded by previous years of disinvestment. One county engineer explained, “We were catching up, catching up, catching up. We were so behind. We still are behind.” Of note, these deferred costs did not disappear. Rather, they were shifted to the future and became an added complication when UOG development began in earnest.

Additionally, state and local roads in North Dakota were simply not built to facilitate industrial development or withstand impacts from UOG. State roads were

originally designed to efficiently move people *through* the region as opposed to *within* the region. When the boom began, this was a major challenge: UOG traffic is heavily reliant on intra-regional roads to connect remote well sites with service centers, storage tanks, and transport hubs. Many of the intra-regional roads that did exist, typically county and township roads, were “mucker roads” – dirt or gravel roads, often built before the 1940s, that were not formally designed by an engineer (Carlson and Sprunk 1979). These roads had low structural numbers^[5] and aggregate sub-bases of less than six inches, making them ill-suited for industrial traffic (Tolliver et al. 2012). For example, county roads in McKenzie County had an average width of only 20 feet, though the recommended width for oil-impacted county roads is 28 feet (Tolliver and Dybing 2010). While these roads were sufficient for the low-volume traffic that characterized the region before the boom, they were not built to withstand the heavier industrial traffic associated with UOG development (Dybing 2012).

Thus, when the UOG boom began, the impacts to roads almost immediately created a crisis (e.g., Donovan 2015). Legislators recognized UOG’s impacts to road systems but did not provide a comprehensive strategy to address impacts until 2015. In 2015 Legislators passed the SURGE bill, allocating over \$1.1 billion to infrastructure needs, the majority of which was spent on western North Dakota’s roads. The bill was framed specifically as an effort to advance industry’s development. Senator Armstrong testified in support the bill explaining, “The two major factors that can curtail the energy industries (*sic*) continued success in North Dakota are price and infrastructure” (SB 2103, January 16, 2015). Additionally, the bill mandated that any road that was built or

upgraded using SURGE funds had to be built to accommodate and withstand industrial traffic, including upgrading road weight limits to 105,000 lb. and implementing a 55 m.p.h. speed limit (SB 2103). Clearly, the bill was intended to promote industry through infrastructure investments. The SURGE funding led to a massive effort by NDDOT, county, and city governments to reconfigure the regional road system to better facilitate industrial development, prompting a boom in road construction.

The SURGE bill's infusion of one-time construction funds had long-term implications for state, county, and local road budgets. None of the monies associated with SURGE could be used for maintenance or operations, though roads have predictable future maintenance needs and expenses. The one-time, concentrated mass buildout meant that miles upon miles of pavement were reconfigured to have the same maintenance schedule – counter to best practices which aim to spread these costs out over time. While the bill could have established bonds for future maintenance expenses, it instead amplified the lumpiness of road asset management. Significant funds will be needed in the future for widespread maintenance work, creating future fiscal cliffs for local governments. While North Dakota had the budget surplus in 2015 to invest a large amount of capital into road infrastructure, whether or not there will be surpluses in the future to maintain these investments is uncertain. The investment in infrastructure to accommodate industry today also shifts costs into the future – past infrastructure decisions to meet UOG's needs mean that communities will continue to pay for UOG impacts long into the future.

Cost Shifting through Space: Traffic Maneuvering

Cost shifting through space and traffic maneuvering was another strategy that government employees used to manage UOG impacts, particularly when their budgets were insufficient. NDDOT offers a stark example. While the NDDOT district office's budget increased from \$17 million to \$300 million during the boom, the office's operational budget remained stagnant. Counterintuitively, when the agency was most flush and having its largest construction season ever, it also had to cut routine maintenance operations due to budget constraints. Since NDDOT did not have sufficient revenue to address UOG impacts, the agency used its overweight permitting process to direct heavy truck traffic off their paved roads and on to unpaved county roads. This was an explicit and strategic decision. Paved roads are far more expensive to maintain than gravel roads. During a public meeting, a NDDOT employee directly stated, "We've always tried to minimize how much they're driving on our paved roads – if they can take a county road that's gravel." However, as noted before, governance and funding for roads are highly fragmented. When NDDOT directed traffic away from their roads and on to county roads, they shifted costs to new spaces. As soon as a truck drives on a county road, it becomes the county's responsibility to maintain and repair that road. NDDOT's strategy for managing UOG impacts relied on re-shifting industry's costs from the state to the county – and, more precisely, from state budgets to county budgets.

At the local level, governments also participated in cost-shifting across space. When it rains in North Dakota gravel roads can be easily damaged by trucks. In response, counties in North Dakota temporarily restricted travel on these roads. One official

discussed how, prior to having the authority to close roads, the county had to pay for costly repairs after weather events:

I remember one time we had a big rain event, and we figured that by the time we were done, there was probably \$50 million worth of damage to the county's roads, because we didn't have a mechanism in place to shut anything, and they [industry] didn't stop.

Given the vulnerability of gravel roads after rain events, the ability to restrict traffic is a critical strategy for managing UOG impacts in North Dakota. However, just over the border in Montana, counties do not have authority to impose similar restrictions. For truck traffic near the border, closed county roads in North Dakota prompt more traffic to travel on Montana roads. The damage is problematic as Montana has significantly less oil production and thus very limited revenues from oil production to assist with damage. The costs associated with drilling and maintaining oil wells are shifted on to taxpayers in spaces that do not host oil and gas production.

Cost Shifting through Labor: Uncompensated Time and Industry Partnerships

While UOG development created many jobs, it also prompted new burdens for government employees and elected officials. For the region's transportation decisionmakers, jobs that had previously been 40 hours per week required extensive overtime as they struggled to keep up with industry's impacts to roads. Burnout for these employees was common. As one NDDOT engineer explained, "I was really busy. I was working 70–80 hours a week, that I would actually put my time in on. I was doing phone calls and stuff. I couldn't go on vacation... I had my phone with me, and I was working the whole time. I was always working. My wife wasn't too happy." UOG development

could not have continued without the additional time that government employees invested into addressing impacts and maintaining roads. The costs of UOG development were shifted on to state and local governments in the form of additional (and often uncompensated) labor.

At the township level, officials serve in their elected roles as volunteers, and for those who live in highly impacted communities managing the roads was very time intensive. One township official explained,

I never really kept track of how much time we spent riding people and making sure things are done right. So, for a while it felt like a full time job... Did a lot of things in the morning when you couldn't do anything else. 7:00 AM meetings with the construction people, with the oil companies...

This official went on to illustrate how personal oil impacts can be at the most local levels of government:

The oil companies also know county officials aren't going to do anything. When you start dealing with an irate farmer...I can pull a combine up and down the road and you can't do nothing about it. So all of a sudden I'll be slowing your ass down, so you can either abide by my rules or I can slow you down. There are ways of working things!

As this quote demonstrates, local elected officials can take active roles in managing UOG development, but the burden is on the individual – who may or may not be compensated for their time. Notably, of the township officials who responded to the roads survey, 55% noted that their township governments had to meet more frequently due to boom impacts to roads. Again, these costs are not typically accounted for in assessments of UOG's costs and benefits, but they are externalities that are a direct outcome of industry's impacts to the roads.

Industry partnerships are another form of cost shifting that occurred in the Bakken. County, city, and township governments regularly partner with industry to assist with road construction and/or maintenance. Partnerships range from formal contracts to informal “handshake deals” with industry. Partnerships at the township level are particularly common. In the survey of township officials, 27 of the 44 respondents (61%) indicated that they had informally partnered with industry, and ten of those responses noted that they also had formal contracts with industry. Four township officials explained that industry provided money to pave roads in their jurisdictions, and in 12 townships industry paid to construct a road that would later become the responsibility of the township. For townships with significant UOG impacts or insufficient funds, industry partnerships were a key and necessary strategy to manage impacts.

Partnerships with industry allowed local governments to shift costs of damaged roads back to industry, but the benefits and duration of partnerships were often uncertain. Due to the overwhelming nature of the UOG industry, local governments typically welcomed industry assistance out of necessity. When a company agrees to finance a turn lane or pays to pave a road, local governments welcome the “free” improvements. However, these also became opportunities in which industry was able to direct the agendas of local governments. For example, one county employee described how their partnership with industry began: “And they [the natural gas plant] actually approached us and said, ‘Hey, if we came up with some funds, would the county be able to prioritize paving a road?’” And the county agreed, even though this road did not align with the county’s strategic plan. Further, some communities have relied on industry’s support,

only to have partners back out when oil prices take a downturn. Communities that partner with industry must wrestle with questions about whether or not the investment will be in the public's interest in the long term, regardless of whether industry stays or leaves. Often this is a question of whether or not the community has the budget to maintain the road in the long term if UOG revenue declines. Partnerships can shift labor costs from local governments back to industry but risk creating new problems and over-adapting to industry's needs.

Discussion: Communities Subsidize UOG through Infrastructure Investments

Very little of the oil industry's profits have so far been spent mitigating the negative impacts of oil and helping to transition from an oil economy. Instead they have been plowed back into the industry or dispersed to shareholders. – Bridge and Le Billon 2017

This research investigated how UOG development changed the Bakken's road infrastructure and systems, the range of strategies employed by state and local governments to address UOG impacts to roads, and the long-term implications of transportation infrastructure investments. Put succinctly, UOG transformed and industrialized North Dakota's road system. In addition to new roads and bypasses, the roads have been upgraded to withstand heavier truck loads and reworked so that traffic flows more efficiently within the region. Before the boom, many of the roads were gravel roads that were barely sufficient for its low volumes of traffic. Today, the roads are highly engineered, carefully analyzed and measured, and part of an upgraded system of infrastructure that enables the UOG industry.

Previous research suggests that roads represent a promise of economic development and yet can create new problems (e.g., Harvey and Knox 2015). This paradox holds true in the Bakken as well. Road investments were justified as investments that would address safety concerns and facilitate economic development by promoting UOG development. However, these investments also created new burdens to the public sector. State and local budgets have increased in the short term to address UOG impacts, but the costs of maintaining these upgraded systems will last for decades.

Cost Shifting Is a Defining Feature of UOG

This research argues that cost shifting is a defining feature of UOG development. In the Bakken, state and local governments infused billions of dollars into the region's roads. In doing so, they absorbed the costs of industry's damages to the roads while prioritizing industry's needs: from creating more efficient routes between service hubs and the oil fields to only funding roads that are built strong enough to withstand truck traffic, the region's investments helped enable industry. Cost shifting can occur in different ways and at different scales. For instance, industry shifts its costs on to the public by demanding new and upgraded infrastructure. In response, local and state governments invest heavily in public infrastructure, and in the process re-shift costs into the future, to other jurisdictions, and through labor reallocations. The diverse ways in which local and state governments invest in and enable industry are rarely, if ever, taken into account in assessments of the local costs and benefits of UOG. Will the region's roads become examples of Barnes, Hayter, and Hay's (2001) stormy cyclones of investments and disinvestment? This research illustrates the risk.

Cost-shifting between scales of government is a direct outcome of the uneven distribution of benefits and costs at the local level. When benefits and costs do not match, local and state governments are forced to creatively maneuver to address impacts within their jurisdictional boundaries. The example was offered of how NDDOT uses its permit system to direct UOG traffic from their paved roads to county gravel roads, shifting costs from state budgets to county budgets. These strategies were not maliciously intended but rather a consequence of the fragmented structures that govern roads and policies that disincentivize regional, collaborative solutions to road impacts.

Similarly, the SURGE bill's long-term implications demand reflection on the nature of resource-dependent economies. The 2015 SURGE funding prompted a boom in road construction but ignored the massive future funding necessary for operations and maintenance. Many miles of roads will have to be maintained at the same time, creating long-term risks to county and state budgets. Whether or not these governments will have funds available to maintain their road investments into the future is uncertain. Even prior to the collapse of oil markets in 2020 due to COVID-19, government employees were nervous about these future costs. It remains to be seen how much of the road infrastructure investments will remain useful for economic activity in the future. Abandoned roads are not without precedence in North Dakota. In the 1990s, when many local government budgets were in crisis, programs were established to de-pave local roads to decrease road maintenance burdens (Ova and Hough 1999). Given the uneven impacts of UOG, future consequences will probably be equally as uneven – with some

governments able to maintain their infrastructure investments and others having to abandon them. This extends the risk of a “bust” long into the future.

Cost-shifting is key to understanding the short- and long-term socioeconomic outcomes of UOG development. Due to the magnitude of UOG in the Bakken and the industry’s outsized impact on the regional economy, public infrastructure decisions carry a risk of deepening dependence on UOG. As governments adapt local and regional infrastructure to meet the needs of a single economic sector, they also limit their flexibility. If UOG disappears, it will be challenging to repurpose the Bakken’s super-sized industrialized road network for other functions. Further, the investments they have made require continued revenues from UOG taxes just to be able to maintain them. If UOG declines or ends, the region will have an infrastructure system that is overbuilt and inappropriate for a region without industrial demands. This leaves state and local governments in a conundrum: many road investments are necessary to ensure public safety during UOG booms, but they can simultaneously entrench dependence by over-accommodating industry, particularly in geographies that are rural and remote (Connelly and Nel 2016; Hayter and Patchell 2015). These mechanics of dependence, as well as alternative strategies for local governments, demand more attention.

Local Governments Play an Outsized Role in Managing UOG Impacts but Are Constrained

This research demonstrates the importance of local governments in regions that host UOG development. Drilling patterns for UOG wells are dispersed across large regions, implicating remote county and township roads (and governments) into their systems. While Krupnick, Echarte, and Muehlenbachs (2017) argue that the benefits local

governments receive from UOG often outweigh the costs, the on-the-ground realities of impacts are far messier. UOG hinges on hard-to-discern externalities. How can analysts account for the opportunity costs of public infrastructure investments when industry's needs are prioritized over the community's? Local revenue increases may or may not be sufficient to account for damages from UOG, but the industry's full range of costs it imposes on local governments are often overlooked – from opportunity costs to future maintenance costs to uncompensated labor. These inputs are all examples of how local communities subsidize the UOG industry at the local level.

As local governments try to maximize benefits from UOG and minimize costs, they are constrained by fragmented governance structures, unpredictable revenues and funding streams, and the overwhelming pace and scale of UOG development. However, local governments have some tools to hold industry accountable for road damages. Overweight permits and impact fees can help recoup costs, though they do not suffice as a strategy of accountability. Road restrictions, such as closing gravel roads after rain events, can be critical in preventing damages. Governments without this authority are greatly disadvantaged, as demonstrated by the Montana counties who absorb traffic (and associated costs) when North Dakota's roads are restricted. Partnerships with industry can address short-term needs but can also lead to decisions that over-accommodate industry. Communities interested in industry partnerships should sign formal contracts to ensure more balanced relationships. Collectively, these tools are important but also piecemeal and insufficient. The impacts of UOG to roads illustrate the need for more

regional coordination, as well as federal and state energy policies that could regulate industry's development in ways that align better with community needs.

Future Research

As demonstrated in this research, many of the costs associated with public infrastructure investments are overlooked in the literature, though they can be substantial and can lead to undesired path dependencies. More research is needed to identify the broader suite of the costs and benefits associated with UOG. How do infrastructure investments create and constrain future economic opportunities for communities? What are the long-term costs and who will pay them? How much labor related to managing UOG is uncompensated? Further, this research's findings speak to larger policy discussions about how federal and state fiscal policies are failing communities with UOG development (Haggerty 2020). On a practical level, stable and predictable funding is needed to assist regions with UOG with coordinated regional planning, infrastructure investments and long-term maintenance, and planning for long-term economic transitions. Finally, tribal roads are not included in this analysis but infrastructure research that addresses the intersection of UOG development and the legacies of settler colonialism are greatly needed and offer an obvious path for future research.

Conclusion

Roads are infrastructural outcomes of UOG development. The boom reshaped western North Dakota's road system, transforming it into an industrialized network marked by physical, financial, and governance changes. Since the boom began over a

decade ago, state and local governments have reworked the region's roads into a highly engineered and more efficient network, albeit not always strategically or collaboratively. Industry's development was rapid and geographically unpredictable, forcing local decisionmakers to be reactive and making planning nearly impossible, particularly during the peak years of development. The magnitude of the boom's impacts to communities was overwhelming and the state's policies did little to shield state agency and local government budgets from the market's volatility. In response, governments addressed UOG impacts by employing strategies that shifted industry's costs across space, time, and labor.

This research argues that roads are critical ways in which communities accommodate UOG. Communities that host UOG will inevitably need to increase their transportation maintenance budgets and likely will need to build new roads and improve existing ones to meet the demands of industry. This local accommodation is often overlooked but – as this research demonstrates – requires a significant amount of time, money, and resources from local and state governments. As these tasks are funded by taxpayers, roads are a way in which the public enables and subsidizes the UOG industry. In this light, roads pose a risk of further entrenching dependence on UOG. This research demonstrates that public infrastructure investments are a key factor in how communities are able or unable to capture long-term benefits from resource extraction.

Endnotes

- ^[1] Dunn County does not have any organized townships. The county is responsible for the construction and maintenance of unorganized townships' roads.
- ^[2] Townships are a product of the Public Land Survey System (PLSS), which divided North Dakota into 6-mile square grids (Manz 2013). North Dakota's Centennial Code designates sections lines in townships as public access, unless closed by the township government. Not all townships have organized governments. For unorganized townships, the county is tasked with constructing and maintaining roads.
- ^[3] The federal government does not have constitutional authority to construct or maintain roads (Petroski 2016), but it does provide critical funding support for state transportation departments. Its primary tool, the Federal Highway Trust, was established in 1956 to fund the Interstate Highway System using the federal fuel tax. Today, the federal fuel tax on gasoline and diesel fuels help fund road construction and paving projects, as well as mass transit systems. Notably, only 17% of North Dakota's road mileage is eligible for federal aid funding (UGPTI and NDDOT 2018).
- ^[4] North Dakota also invests 30% of its oil extraction tax revenues into a Legacy Fund, a fund established in 2010 meant to transform "finite national resources of oil and natural gas" into perpetual revenue; as of March 2020 the fund currently holds over \$6 billion (North Dakota Office of State Treasurer n.d.)
- ^[5] A road's structural number is a product of its surface thickness and base materials, as well as its material makeup. It measures the structural strength of the pavement and has implications for how heavy traffic will impact the road. The higher the number, the heavier truck traffic the road is designed to accommodate. A 2010 UGPTI report noted that oil-impacted county roads had an average structural number of only 1.1 (Tolliver and Dybing 2010).

References Cited in Chapter Seven

- Abramzon, S., C. Samaras, A. Curtright, A. Litovitz, and N. Burger. 2014. Estimating the consumptive use costs of shale natural gas extraction on Pennsylvania roadways. *Journal of Infrastructure Systems* 20 (3).
- Appel, H., N. Anand, and A. Gupta. 2018. Introduction: temporality, politics, and the promise of infrastructure. In *The promise of infrastructure*, ed. N. Anand, A. Gupta, and H. Appel, 1–40. Durham, NC: Duke University Press.
- Appel, H., A. Mason, and M. Watts. 2015. Introduction: oil talk. In *Subterranean estates: life worlds of oil and gas*, ed. H. Appel, A. Mason, and M. Watts, 1–26. Ithaca, NY: Cornell University Press.
- Barnes, T. J., and B. Christophers. 2018. *Economic geography: a critical introduction*. Hoboken, NJ: John Wiley & Sons.
- Barnes, T. J., R. Hayter, and E. Hay. 2001. Stormy weather: cyclones, Harold Innis, and Port Alberni, BC. *Environment and Planning A* 33 (12): 2127–47.
- Barth, J. M. 2013. The economic impact of shale gas development on state and local economies: benefits, costs, and uncertainties. *New Solutions: A Journal of Environmental and Occupational Health Policy* 23 (1): 85–101.
- Berwick, M., K. Vachal, K. Johnson, and J. Baker. 2010. County road survey for Transportation Managers. Rural Transportation Safety and Security Center at the Upper Great Plains Transportation Institute, North Dakota State University, Fargo. <https://www.ugpti.org/resources/reports/downloads/dp-238.pdf>.
- Bogart, B. 2019. How the oil industry and region benefit and support the state: oil and gas tax revenues. Jadestone Consulting, compiled for North Dakota Petroleum Council and the Western Dakota Energy Association, Bismarck, ND. <https://taxstudy.ndenergy.org/TaxStudy>.
- Brasier, K., L. Davis, L. Glenna, T. Kelsey, D. McLaughlin, K. Schafft, K. Bobbie, C. Biddle, A. Delessio-Parson, and D. Rhubarb. 2014. The Marcellus Shale impacts study: chronicling social and economic change in North Central and Southwest Pennsylvania. Center for Rural Pennsylvania, Harrisburg, PA.
- Bratlien, A., A. Dybing, L. Holt, T. Horner, Y. Kazemi, E. Lee, P. Lu, J. Mielke, D. Tolliver, B. Wentz, V. Dang, C. DeHaan, N. Dharmadhikari, C. Ifepe, Y. Shin Park, F. Yuan, and Z. Zheng. 2014. Infrastructure Needs: North Dakota's County, Township and Tribal Roads and Bridges: 2015-2034. Report for the North Dakota

Legislative Assembly. Upper Great Plains Transportation Institute, North Dakota State University, Fargo, ND.

- Bridge, G. 2009. Material worlds: natural resources, resource geography, and the material economy. *Geography Compass* 3 (3): 1217–44.
- Bridge, G. 2018. The map is not the territory: a sympathetic critique of energy research’s spatial turn. *Energy Research and Social Science* 36: 11–20.
- Bridge, G., and P. Le Billon. 2017. *Oil*. 2nd ed. Malden: Polity Press.
- Buse, C. G., M. Sax, N. Nowak, J. Jackson, T. Fresco, T. Fyfe, and G. Halseth. 2019. Locating community impacts of unconventional natural gas across the supply chain: a scoping review. *The Extractive Industries and Society* 6 (2): 620–9.
- Bouzarovski, S., M. Bradshaw, and A. Wochnik. 2015. Making territory through infrastructure: the governance of natural gas transit in Europe. *Geoforum* 64: 217–28.
- Calvert, K. 2016. From “energy geography” to “energy geographies”: perspectives on a fertile academic borderland. *Progress in Human Geography* 40 (1): 105–25.
- Cameron, P. D., and M. C. Stanley. 2017. *Oil, gas, and mining: a sourcebook for understanding the extractive industries*. Washington, DC: The World Bank.
- Carlson, R. L. and L. J. Sprunk. 1979. *History of the North Dakota State Highway Department*. North Dakota State Highway Department, Bismarck, North Dakota.
- Carse, A. 2014. *Beyond the big ditch: politics, ecology, and infrastructure at the Panama Canal*. Cambridge, MA: MIT Press.
- Carse, A., and J. A. Lewis. 2017. Toward a political ecology of infrastructure standards: or, how to think about ships, waterways, sediment, and communities together. *Environment and Planning A* 49 (1): 9–28.
- Chambers, C. 2020. Beneath the surface: capital-labor relations, housing and the making of the Bakken boom. *The Extractive Industries and Society* 7 (3): 908–17.
- City of Dickinson. 2013. Dickinson 2035: roadmap to the future. Transportation master plan. Prepared by KLJ.
- Clark, L., M. Lee, and C. Anchondo. 2020. Head-scratching at the White House as oil crash continues. *E&E News*, April 22.

<https://www.eenews.net/energywire/stories/1062938449/search?keyword=negative+oil+price>.

- Connelly, S. and E. Nel. 2016. Restructuring of the New Zealand economy: global-local links and evidence from the west coast and southland regions. In *Transformation of resource towns and peripheries*, ed. G. Halseth, 136–60. New York: Routledge.
- Donovan, L. 2015. Highway 85 leads deadly statistics. *Bismarck Tribune*, February 14. https://bismarcktribune.com/bakken/highway-85-leads-deadly-statistics/article_3651cf63-28e9-5ac2-ad91-c75699e03088.html.
- Drache, D. 1995. Celebrating Innis: the man, the legacy, and our future. In *Staples, markets, and cultural change: selected essays*, ed. H. A. Innis and D. Drache, xiii–lix. Montreal: McGill-Queen’s University Press.
- Drew, J., B. E. Dollery, and B. D. Blackwell. 2018. A square deal? Mining costs, mining royalties and local government in New South Wales, Australia. *Resources Policy* 55: 113–22.
- Dybing, A. G. 2012. Estimation of increased traffic on highways in Montana and North Dakota due to oil development and production. PhD diss., North Dakota State University of Agriculture and Applied Science.
- Dybing, Alan. 2018. Local transportation funding sources. Paper presented at North Dakota Symposium on Transportation Funding, Upper Great Plains Transportation Institute, Bismarck, North Dakota, March 14. <https://www.dot.nd.gov/public/docs/fundingsymposium/ND%20Local%20Funding%20Sources%20UGPTI%20presentation.pdf>.
- Dybing, A., P. Lu, D. Heglund, T. Horner, M. Jaroszynski, T. Jirik, B. Wentz, A. Wrucke, L. Holt, C. DeHaan, Y. Shin Park, P. Kayabas, Y. Xu, O. Khan, F. Yuan, A. R. Taleqani, Z. Zheng, and C. Ifepe. 2016. Infrastructure needs: North Dakota’s county, township and tribal roads and bridges: 2017–2036. Report for the North Dakota Legislative Assembly. Upper Great Plains Transportation Institute, North Dakota State University, Fargo, ND.
- Dybing, A., P. Lu, D. Heglund, T. Horner, T. Jirik, B. Wentz, K. Bengtson, S. S. Wadhwa, N. Dhingra, and S. Hasan. 2020. Infrastructure needs: North Dakota’s county, township and tribal roads and bridges: 2021–2040. Report for the North Dakota Legislative Assembly. Upper Great Plains Transportation Institute, North Dakota State University, Fargo, ND.

- Energy Infrastructure and Impact Office. N.d. Energy infrastructure and impact office grants. Accessed October 17, 2020. <https://www.land.nd.gov/energy-infrastructure-impact-office-eiio-grants>.
- Freudenburg, W. R. 1992. Addictive economies: extractive industries and vulnerable localities in a changing world economy. *Rural Sociology* 57 (3): 305–32.
- Glaeser, E. L. 2016. If you build it...Myths and realities about America's infrastructure spending. *City Journal*, Summer.
- Goodman, C., M. E. Hatch, and B. D. McDonald III. 2020. State preemption of local laws: origins and modern trends. *Perspectives on Public Management & Governance*. <https://doi.org/10.1093/ppmgov/gvaa018>.
- Graham, J., J. Irving, X. Tang, S. Sellers, J. Crisp, D. Horwitz, L. Muehlenbachs, A. Krupnick, and D. Carey. 2015. Increased traffic accident rates associated with shale gas drilling in Pennsylvania. *Accident Analysis & Prevention* 74: 203–9.
- Hageman, J. 2019. Despite pleas for road funding, North Dakota senate rejects gas tax increase. *Bismarck Tribune*, February 4. https://bismarcktribune.com/news/local/govt-and-politics/despite-pleas-for-road-funding-north-dakota-senate-rejects-gas/article_731ec69f-503a-52cf-a51c-1f12246eed71.html
- Haggerty, J. H., A. C. Kroepsch, K. B. Walsh, K. K. Smith, and D. W. Bowen. 2018. Geographies of impact and the impacts of geography: unconventional oil and gas in the American West. *The Extractive Industries and Society* 5 (4): 619–33.
- Haggerty, J. H., K. K. Smith, J. Weigle, T. W. Kelsey, K. B. Walsh, R. Coupal, D. Kay, and P. Lachapelle. 2019. Tradeoffs, balancing, and adaptation in the agriculture-oil and gas nexus: insights from farmers and ranchers in the United States. *Energy Research & Social Science* 47: 84–92.
- Haggerty, M. 2020. *How fiscal policy is failing rural America*. Headwaters Economics, Bozeman, MT.
- Haarstad, H., and T. I. Wanvik. 2017. Carbonscapes and beyond: conceptualizing the instability of oil landscapes. *Progress in Human Geography* 41 (4): 432–50.
- Harvey, P., and H. Knox. 2015. *Roads: an anthropology of infrastructure and expertise*. Ithaca, NY: Cornell University Press.

- Hayter, R., T. J. Barnes, and M. J. Bradshaw. 2003. Relocating resource peripheries to the core of economic geography's theorizing: rationale and agenda. *Area* 35 1: 15–23.
- Hayter, R., and J. Patchell. 2015. Resource geography. *International Encyclopedia of the Social and Behavioral Sciences*. 2nd ed. 20: 568–75.
- Horn, A. 2019. Gas tax increase draws no opposition in committee, but at the pump. *KFYR TV*, January 22. <https://www.kfyrtv.com/content/news/Gas-tax-increase-draws-no-opposition-in-committee-but-at-the-pump-504728871.html>.
- Howe, C., J. Lockrem, H. Appel, E. Hackett, D. Boyer, R. Hall, M. Schneider-Mayerson, A. Pope, A. Gupta, E. Rodwell, et al. 2016. Paradoxical infrastructures: ruins, retrofit, and risk. *Science Technology & Human Values* 41 (3): 547–65.
- Huber, M. T. 2017. Hidden abodes: industrializing political ecology. *Annals of the American Association of Geographers* 107 (1): 151–66.
- Humphreys, M., J. D. Sachs, J. E. Stiglitz, G. Soros, and M. Humphreys. 2007. *Escaping the resource curse*. New York: Columbia University Press.
- Jacquet, J. 2014. Review of risks to communities from shale energy development. *Environmental Science & Technology* 48 (15): 8321–33.
- Kaika, M. 2005. *City of flows: modernity, nature, and the city*. New York: Routledge.
- Kim, J., and T. G. Johnson. 2020. The shale oil boom and comprehensive wealth of the Bakken region of North Dakota. *Community Development*: 1–21.
- Keough, S. B. 2015. Planning for growth in a natural resource boomtown: challenges for urban planners in Fort McMurray, Alberta. *Urban Geography* 36 (8): 1169–96.
- Kraenzel, C. F. 1955. *The great plains in transition*. Norman: University of Oklahoma Press.
- Kroepsch, A. C., P. T. Maniloff, J. L. Adgate, L. M. McKenzie, and K. L. Dickinson. 2019. Environmental justice in unconventional oil and natural gas drilling and production: a critical review and research agenda. *Environmental Science & Technology* 53 (12): 6601–15.
- Krupnick, A. J., I. Echarte, and L. Muehlenbachs. 2017. Local government impacts of unconventional oil and gas. *The Community Impacts of Shale Gas and Oil Development, Resources for the Future*, Washington, DC.

https://media.rff.org/archive/files/document/file/RFF-Rpt-ShaleReviews_LocalGovt_0.pdf.

- Junod, A. N., J. B. Jacquet, F. Fernando, and L. Flage. 2018. Life in the goldilocks zone: perceptions of place disruption on the periphery of the Bakken Shale. *Society & Natural Resources* 31 (2): 200–17.
- LoadPass Permits. 2020. About the LoadPass permit program. Accessed October 17, 2020. <https://permits.loadpasspermits.com/About/Program>.
- Maciag, M. 2012. North Dakota leads in hyper-local government. *Governing*, September 13. <https://www.governing.com/news/state/gov-north-dakota-most-governments-per-capita.html>.
- Malin, S. A., T. Opsal, T. O'Connor Shelley, and P. M. Hall. 2019. The right to resist or a case of injustice? Meta-power in the oil and gas fields. *Social Forces* 97 (4): 1811–38.
- Manz, L. 2013. The public land survey system (PLSS) part 1. *North Dakota Geological Survey Geo News*. <https://www.dmr.nd.gov/ndgs/documents/newsletter/2013Summer/PLSS-Part1.pdf>.
- Mayer, A. 2017. Quality of life and unconventional oil and gas development: towards a comprehensive impact model for host communities. *The Extractive Industries and Society* 4 (4): 923–30.
- Mayer, A., and S. Malin. 2018. Keep it local? Preferences for federal, state, or local unconventional oil and gas regulations. *Energy Research & Social Science* 44: 336–45.
- McNally, R. 2017. *Crude volatility: the history and the future of boom-bust oil prices*. New York: Columbia University Press.
- Measham, T. G., D. A. Fleming, and H. Schandl. 2016. A conceptual model of the socioeconomic impacts of unconventional fossil fuel extraction. *Global Environmental Change* 36: 101–10.
- Meehan, K. M. 2014. Tool-power: water infrastructure as wellsprings of state power. *Geoforum* 57: 215–24.
- Murphy, T., C. Brannstrom, M. Fry, and M. Ewers. 2018. Economic-development stakeholder perspectives on boomtown dynamics in the Eagle Ford Shale, Texas. *Geographical Review* 108 (1): 24–44.

- Naismith Engineering, Inc. 2015. DeWitt County road damage cost allocation study. Corpus Christi, TX. <http://tools.cira.state.tx.us/users/0041/DeWittpercent20Countypercent20Roadpercent20Damagepercent20Costpercent20Allocationpercent20Study.pdf>.
- NDDOT (North Dakota Department of Transportation). 2016. State and local officials celebrate completion of Killdeer Truck Bypass project. NDDOT press release, September 28. <https://www.dot.nd.gov/dotnet/news/docs/2016releases/Killdeer%20press%20release.pdf>.
- NDDOT (North Dakota Department of Transportation). 2014. North Dakota Department of Transportation: roads of progress.
- NDDOT (North Dakota Department of Transportation). 2017. NDDOT Williston District: project updates. Paper presented at the 2017 Construction Conference. <https://www.dot.nd.gov/conferences/construction/presentations/2017/Bakken%20Update.pdf>.
- NDDOT (North Dakota Department of Transportation). 2019a. Statewide transportation improvement program: 2020 – 2023 final document. <https://www.dot.nd.gov/manuals/programming/STIP/Final-STIP.pdf>.
- NDDOT (North Dakota Department of Transportation). 2019b. North Dakota transportation handbook 2019. <http://library.nd.gov/statedocs/Transportation/TransportationHandbook/2019.pdf>.
- North Dakota. 2020. Local government. Accessed October 17, 2020. <https://www.nd.gov/government/local-government>.
- North Dakota Oil and Gas Division. N.d. North Dakota annual oil production. <https://www.dmr.nd.gov/oilgas/stats/annualprod.pdf>.
- North Dakota Oil and Gas Division. N.d. Monthly oil production totals by county. Accessed October 17, 2020. <https://www.dmr.nd.gov/oilgas/stats/countymot.pdf>.
- North Dakota Office of State Treasurer. 2019. How is oil and gas tax revenue distributed? Accessed October 17, 2020. <https://www.treasurer.nd.gov/how-oil-and-gas-tax-revenue-distributed>.
- North Dakota Office of State Treasurer. N.d. North Dakota legacy fund. Accessed October 17, 2020. <https://www.treasurer.nd.gov/north-dakota-legacy-fund-0>.

- North Dakota. N.d. Motor Fuel History. Accessed October 17, 2020.
<https://www.nd.gov/tax/motorfuelhistory/>.
- Oates, W. E. 1972. *Fiscal federalism*. New York: Harcourt Brace Jovanovich.
- Olien, R. M., and D. D. Olien. 1982. *Oil booms: social change in five Texas towns*. Lincoln: University of Nebraska Press.
- O'Sullivan, M. L. 2017. *Windfall: how the new energy abundance upends global politics and strengthens America's power*. New York: Simon and Schuster.
- Ova, K., and J. Hough. 1999. Guidelines for consolidating township roads: a case study showing benefit/cost analysis for closing township roads in North Dakota. North Dakota State University, Upper Great Plains Transportation Institute, Fargo, ND.
<https://www.ugpti.org/resources/reports/details.php?id=347>.
- Petroski, H. 2016. *The road taken: the history and future of America's infrastructure*. New York: Bloomsbury.
- Raimi, D. 2017. *The fracking debate: the risks, benefits, and uncertainties of the shale revolution*. New York: Columbia University Press.
- Ross, M. L. 1999. The political economy of the resource curse. *World Politics* 51 (2): 297–322.
- Ryder, S. S. 2017. Unconventional regulation for unconventional energy in Northern Colorado? Municipalities as strategic actors and innovators in the United States. *Energy Research & Social Science* (26): 23–33.
- Sachs, J., and A. Warner. 1995. Natural resource abundance and economic growth. NBER Working Paper No. 5398. National Bureau of Economic Research, Cambridge, MA.
- Schafft, K. A., L. L. Glenna, B. Green, and Y. Borlu. 2014. Local impacts of unconventional gas development within Pennsylvania's Marcellus shale region: gauging boomtown development through the perspectives of educational administrators. *Society & Natural Resources* 27 (4): 389–404.
- Small, M. J., P. C. Stern, E. Bomberg, S. M. Christopherson, B. D. Goldstein, A. L. Israel, R. B. Jackson, A. Krupnick, M. S. Mauter, J. Nash, et al. 2014. Risks and risk governance in unconventional shale gas development. *Environmental Science & Technology* 48 (15): 8289–97.
- Smith, K. K., and J. H. Haggerty. 2018. Devolved governance & alternative dispute resolution programs: an example from the Bakken. In *Governing shale gas:*

development, citizen participation and decision making in the US, Canada, Australia and Europe, ed. K. Brasier, M. Cotton, and J. Whitton, 184–97. London: Routledge.

- Smith, K. K., and J. H. Haggerty. 2020. Exploitable ambiguities and the unruliness of natural resource dependence: public infrastructure in North Dakota's Bakken Shale Formation. *Journal of Rural Studies*.
<https://doi.org/10.1016/j.jrurstud.2020.05.006>.
- Smith, K. K., J. H. Haggerty, D. L. Kay, and R. Coupal. 2019. Using shared services to mitigate boomtown impacts in the Bakken Shale Play: resourcefulness or over-adaptation? *Journal of Rural and Community Development* 14 (2): 66–86.
- Solomon, B. D., M. J. Pasqualetti, and D. A. Luchsinger. 2004. Energy geography. In *Geography in America at the dawn of the 21st century*, ed. G. Gaile and C. Willmott, 302–13. Oxford: Oxford University Press.
- Svihovec, L. 2018. 4-County oil impact analysis: Dunn, McKenzie, Mountrail, and Williams Counties. Western Dakota Energy Association and AE2S Nexus. Energy & Environmental Research Center, Grand Forks, ND, June 24.
- Tolliver, D. 2014. Transportation systems for oil and gas development: case study of the Bakken Shale. Presented at International Transportation and Economic Development (I-TED) Conference, Dallas, Texas, April 9–11.
<https://static.tti.tamu.edu/conferences/ited2014/presentations/A3-tolliver.pdf>.
- Tolliver, D. and A. Dybing. 2010. An assessment of county and local road infrastructure needs in North Dakota. Report for the North Dakota Legislative Assembly. Upper Great Plains Transportation Institute, North Dakota State University, Fargo, ND.
- Tolliver, D., B. Wentz, A. Dybing, P. Lu, A. Bratlien, T. Horner, E. Lee, Y. Kazemi, N. Dharmadhikari, C. DeHaan, L. Holt, C. Ifepe, and S. Shakya. 2012. Additional road investments needed to support oil and gas production and distribution in North Dakota. Report for the North Dakota Legislative Assembly. Upper Great Plains Transportation Institute, North Dakota State University, Fargo, ND.
- U.S. Department of Commerce. 2019. Regional economic accounts. Bureau of Economic Analysis. Washington, DC, as reported by Headwaters Economics' Economic Profile System (headwaterseconomics.org/eps).
- U.S. Geological Survey. 2018. Gap Analysis Program. Protected areas database of the United States (PADUS) version 2.0, as reported in Headwaters Economics' Economic Profile System (headwaterseconomics.org/eps).

- UGPTI (Upper Great Plains Transportation Institute). 2013. North Dakota truck size and weight education program: a cooperative project between North Dakota Department of Transportation, North Dakota Highway Patrol, North Dakota Local Technical Assistance Program and Upper Great Plains Transportation Institute, Fargo, ND.
- UGPTI (Upper Great Plains Transportation Institute) and NDDOT (North Dakota Department of Transportation). 2018. North Dakota Symposium on Transportation Funding, Fargo, ND, June 5. https://www.dot.nd.gov/public/docs/fundingsymposium/UGPTI%20Report%20ND%20Symposium%20on%20Transportation%20Funding_June0518FINAL.pdf.
- Urban Institute. 2020. Highway and road expenditures. State and local finance initiative. Accessed October 2017, 2020. <https://www.urban.org/policy-centers/cross-center-initiatives/state-and-local-finance-initiative/state-and-local-backgrounders/highway-and-road-expenditures>.
- Wagener, D. V. 2018. Oil and natural gas resources and technology. Annual energy outlook, 2018. U.S. Energy Information Administration, Washington, DC. <https://www.eia.gov/outlooks/aeo/grt.php>.
- Wallerstein, I. 2004. *World-systems analysis*. Durham, NC: Duke University Press.
- Walker, R. A. 2001. California's golden road to riches: natural resources and regional capitalism 1848–1940. *Annals of the Association of American Geographers* 91 (1): 167–99.
- Walsh, K. B., and J. H. Haggerty. 2019. I'd do it again in a heartbeat: coalbed methane development and satisfied surface owners in Sheridan County, Wyoming. *The Extractive Industries and Society* 6 (1): 85–93.
- Watts, M. 2004. Resource curse? Governmentality, oil and power in the Niger delta, Nigeria. *Geopolitics* [Special issue] 9/1.
- WDEA (Western Dakota Energy Association). 2019. 2019 Annual Meeting Presentations, Fargo, ND, October 30–31. <https://ndenergy.org/News/2019-Annual-Meeting-Presentations>.
- WDEA (Western Dakota Energy Association). 2020. About LoadPass permits. Accessed October 17, 2020. <https://www.loadpasspermits.com/About>.
- Wilson, G. 2012. *Community resilience and environmental transitions*. New York: Routledge.

Zimmer, K. S. 2011. New geographies of energy: introduction to the special issue. *Annals of the Association of American Geographers* 101 (4): 705–11.

CHAPTER EIGHT

CONCLUSION: UNCONVENTIONAL OIL AND GAS CREATES DISTINCT
GEOGRAPHIES OF PRODUCTION AND PUBLIC FINANCE

On October 10, 2019 Captain Elliott Monson landed the first commercial plane at Williston Basin International Airport (XWA), the new city-owned airport built in Williston, North Dakota. The airport was built to address a ten-fold increase in passenger travel due to the boom in unconventional oil and gas (UOG) development. For a city of approximately 35,000 people, a new \$274 million airport should have been the news story of the decade: XWA is one of only four newly constructed airports that have opened in the United States since 2000⁵ (Russell 2019). However, XWA is just one of dozens of “supersized” public works projects that have physically and culturally transformed the city of Williston, which serves as a major service center and hub for the UOG industry. The city’s infrastructure – above and below ground – is indicative of the industrialization that has occurred throughout this region, with important ramifications for state and local governments and their budgets.

Over the course of researching and writing my dissertation, it was impossible to ignore the infrastructural outcomes of UOG. By extension, I became increasingly interested in analyzing infrastructure as an entry point into debates about UOG’s benefits and costs, including how UOG shapes public finances in the short and long-term, the

⁵ The other new airports built on greenfield sites include St. George Regional Airport (SGU) in Utah – 2011; Northwest Florida Beaches International Airport (ECP) – 2010; and, Branson (BBG) in Missouri – 2009.

creativity of local leaders in the face of overwhelming impacts, and the failure of state and federal fiscal policies to protect communities from the volatility of global oil markets.

Infrastructure projects are some of the most fundamental ways in which this region has been transformed. Beyond pumpjacks and pipelines, communities throughout the Bakken built and upgraded their landfills, wastewater systems, freshwater systems, transmission lines, hospitals, roads, airports, and city facilities – including new city halls and office buildings, fire stations, police department and justice centers, and recreation facilities (see Appendix A). These investments demonstrate how the Bakken has been urbanized, industrialized, and deeply globalized (Gilbertz, Anderson, and Adkins 2020). Yet, these investments also speak to the local context of the Bakken and demonstrate communities' ability – albeit constrained by their reliance on the global market – to direct their experiences with UOG.

This dissertation demonstrates that infrastructure investments are always more than they seem. Beneath the engineered surfaces of these projects are aspirations for the region, political debates and power struggles, financial risks, and compromise – due to geography, timeframe, costs, and/or politics. As noted in previous boomtown planning research, booms spark a surge in hard infrastructure investments at the beginning of development and then transition into quality of life projects as development stabilizes and worker retention becomes a priority (e.g., Gilmore 1976; Keough 2015). The Bakken has followed this trajectory at the regional scale. As industry has matured, infrastructure projects are increasingly prompting debates about the region's future: What type of

communities do residents want? How can UOG best benefit the region? This dissertation sought to articulate the inner workings of infrastructure projects as a lens for analyzing the broader challenges and opportunities prompted by UOG development.

Dissertation Contributions

Throughout my doctoral research, I sought to make theoretical, methodological, and applied contributions to the scholarship on economic, rural, and resource geography. At its most basic level, this dissertation draws attention to the Bakken, an energy geography that has historically been under-researched when compared to other shale formations (Walsh and Haggerty 2020). As a resource periphery contributing to global capital flows, the Bakken holds important lessons for researching the costs and benefits of industrial energy development.

Second, I intentionally developed a research approach that I describe as being “critically empathetic and empathetically critical.” On the one hand, I investigated how the political economy of the UOG industry shapes local places using a critical lens and in the spirit of political ecology’s metaphorical “hatchet” (e.g., Robbins 2012). On the other hand, I also came to understand local and regional leaders’ decisions as practical solutions made in the context of overwhelming challenges and thus strove to present these strategies empathetically as opposed to only offering critique. To do this, I employed predominantly qualitative research methods. I repeatedly found in my data examples of local ingenuity and innovation that crossed political boundaries and defied researchers’ assumptions about boomtowns. Community members in the Bakken have

worked hard to improve their communities and manage impacts from UOG, and their efforts demand more recognition and celebration from researchers.

Third, my research exposes the significant amount of accommodation and investment that UOG requires from local communities. This local subsidization of industry – often in the form of public infrastructure investments and public sector labor (including uncompensated labor) – needs to be taken seriously as researchers search for strategies that help communities and regions leverage UOG development into long-term benefits. To elaborate more on this third point, I have identified five cross-cutting themes that emerge from the research chapters of this dissertation. I argue that UOG is a distinct geography of production *and* a distinct geography of public finance. I end with a brief discussion of future research ideas and an overview of how COVID-19 is impacting the UOG industry and the Bakken.

UOG Is a Distinct Geography of Production.

UOG Is Regional in Nature and Requires Regional Infrastructure

UOG development is a *regional* endeavor. UOG drilling has a dispersed pattern, a response to both geology and spacing unit regulations (Cameron and Stanley 2017), and consequently it impacts a broader region beyond just a boomtown. Communities within the Bakken, particularly Williston and Watford City, experienced classic boomtown impacts – summarized by Gilmore (1976) as consisting of rapid growth and stressed government services and infrastructure. UOG development, however, differs from conventional booms in that UOG development migrates across the region creating mini-

booms and busts as it travels (Jacquet and Kay 2014). Thus, boomtown experiences occur within a regional context with complex multi- and inter-scalar interactions between and amongst state and local governments. The distribution of costs and benefits throughout the Bakken is also highly uneven, a finding that aligns with previous UOG research (e.g., Jacquet 2014; Jacquet et al. 2018).

The dispersed nature of UOG drilling created a need and an opportunity for more coordinated and distributed infrastructure throughout the region. In addition to labor, industry requires sand, chemicals, drilling mud, cement, gravel or scoria, fuel, frac and cement pumper trucks, rig equipment, frac tanks, pipes, and workover rigs. These inputs and equipment must be trucked in, and outputs, including processed water, oil, and natural gas, must be transported away from the well. Regional roads, rail systems, and pipelines are critical components of industry's assemblage. These regional needs prompted opportunities in the Bakken. For instance, the project team for the Western Area Water Supply project leveraged the regional growth in freshwater demand into a rural water project that they had wanted for decades (chapter six). The project coordinated the work for five separate water entities and addressed previous territorial disputes. UOG traffic also created the opportunity to improve regional road networks (chapter seven). State and local governments focused on improving intra-regional travel by identifying and upgrading main artery roads, constructing truck reliever routes, and building new roads. UOG development prompted additional regional infrastructure investments not discussed in this dissertation, such as a massive build out and upgrade to the region's transmission lines.

While the need for regional infrastructure is acute, jurisdictional boundaries trouble coordination and investments in regional infrastructure, as demonstrated in the roads research (chapter seven). The fragmented governance of road systems created barriers to optimizing a regional road system and also prompted cost-shifting tactics amongst different governments. Political boundaries are exacerbated by the uneven impacts of UOG. Places that experienced the heaviest impacts did not always receive the most benefits and vice versa, creating disincentives to collaborate. Challenges with inter-municipal cooperation are not unique to the Bakken (e.g., Warner 2017). Nonetheless, this dissertation demonstrates the need for more coordination, echoing Morrison's (2016) calls for addressing UOG's local impacts by building adaptive capacity through policies that support, fund, and incentivize regional collaborations. These collaborations could potentially be funded with aid from the UOG industry (Measham, Fleming, and Schandl 2016).

Local Governments, Community Organizations, and Landowners Play an Outsized Role in Managing UOG Impacts.

Previous literature has emphasized that, in the absence of a national energy policy in the United States, state governments are the primary actors regulating the UOG industry (Small et al. 2014; Zirotiannis et al. 2016). This holds true in North Dakota. Nonetheless, this research also contributes to the growing body of literature on the role that local stakeholders play in the governance of UOG. Specifically, it demonstrates that local governments and stakeholders are the primary actors *managing* UOG development's on-the-ground impacts.

Throughout the Bakken, governments at the county, city, and township scales invested in infrastructure, services, and programs to address, manage, and leverage UOG impacts. In addition to public works infrastructure, governments invested in equipment, job training programs, affordable housing, childcare services, office buildings, and recreation facilities, to name a few. Appendix A offers a table summarizing the region's larger infrastructure investments, many of which were implemented by local governments. Local governments also regulated impacts and managed growth through land use ordinances, permits and impact fees, and road restrictions. For instance, one of the more significant, albeit often overlooked, changes in the Bakken was the implementation of county-wide zoning. Additionally, county and city governments created new departments and hired new employees to address impacts. As Olien and Olien (1982) argue, while people associate oil booms with lawlessness, in practice booms create massive expansions in governments. This occurred throughout the Bakken and was particularly true for local government departments. Local government employees and elected officials are the front-line workers managing UOG development.

Regional organizations in western North Dakota are other important actors in UOG's governance. My doctoral research observes that the Northwest Landowners Association (chapter four), the Western Dakota Energy Association (chapter seven), and Vision West ND each played important convening roles in the infrastructure projects I analyzed. The Western Dakota Energy Association has been influential in elevating landowner concerns to state policy levels. For instance, their work on pipeline reclamation resulted in the Department of Agriculture's pipeline ombudsman program

(chapter four). The Western Dakota Energy Association's LoadPass system for coordinating overweight permits for county and local governments is an innovative solution for managing UOG impacts to roads (chapter seven). Prior to the system, UOG companies had to individually call each local government to get separate overweight permits every time they crossed a jurisdictional boundary. LoadPass streamlined the system for industry and local governments. Vision West ND has developed multiple reports about local infrastructure needs, helping to convince North Dakota legislators to reinvest revenues into the region. These regional organizations have played important roles in easing the community burdens of UOG impacts.

In the Bakken most UOG development occurs on private property, leaving individual landowners to negotiate the terms and conditions of extraction on their own property. Landowners can shape how UOG development occurs on their land, but this "private participation" form of planning often does not address regional or cumulative impacts (Jacquet 2015). Further, the outcomes are highly uneven and dependent on an individual's access to resources: some landowners reportedly feel empowered from their interactions with industry while others feel marginalized (Malin et al. 2019; Walsh and Haggerty 2020). My dissertation reinforces previous findings that landowner experiences are highly variable. As demonstrated in chapter four, many landowners support industry but are simultaneously frustrated by impacts, including reclamation issues on fields. Landowners spend significant amounts of time managing impacts and "babysitting" industry. While the devolved governance of UOG creates opportunities for local

stakeholders to influence change, it also places the onus of governance on individuals, who may or may not have the time, capacity, and resources to manage impacts.

UOG Is Uncoordinated and
Marked by Uncertainty, Data
Gaps, and Lack of Transparency

Although *the UOG industry* is often referred to as a monolithic entity, in practice it is a complex mix of upstream, mid-stream, and down-stream companies of varying scales and with diverse geographic operations. The Bakken predominantly hosts upstream (exploration and production companies) and mid-stream companies (transport, processing, storage, and marketing companies). The UOG industry is highly dynamic with fierce competition, resulting in frequent bankruptcies and consolidations. The hundreds of companies that make up the UOG “industry” are often secretive about their future plans to create an edge over competitors. However, this contributes to the development’s uncoordinated and unpredictable manner, creating planning challenges for local governments, as described in chapters five, six, and seven.

Data gaps and the UOG industry’s lack of transparency are distinct characteristics of regions that host UOG and were recurring themes throughout this project. When the UOG boom began, the region’s population data quickly became obsolete, a problem that persists to this day. Some local leaders created their own methods for estimating their city or county’s population. As one employee described the process, “I use a baseline from the last formal study we had and use a combination of things to estimate the [population] trend: waste water, water, sales tax generation, calls for service, occupancy, traffic counts (when I can get them), school enrollment, and births.” Many local governments take their

population estimates for granted, but accurate population counts in regions with UOG development are rare at best. Consequently, state and local government officials and employees are often forced to make decisions – many with long-term consequences – without sufficient data.

Data gaps are a noted problem in boomtowns (e.g., Jacquet and Kay 2014; Keough 2015) and each research chapter in this dissertation addresses their influence. In chapter five the WAWS project team had to make best guesses about which areas within their region would experience the most growth and thus needed larger water pipelines. The rapid population growth coupled with poor data also created financing challenges for communities. For example, as explained in chapter four, the high school in Watford City was unable to borrow the full amount needed for their loan due to per capita limits. According to city leaders, if the city's population data had kept up with its growth this would not have been an issue. Similarly, planning for infrastructure's future costs was equally challenging, as demonstrated in chapter seven. A report by the Upper Great Plains Transportation Institute warned that their cost estimates for future road maintenance were "theoretical estimates based on little experience about the actual maintenance effects of oil-related traffic." Over and over again, the lack of data and the general uncertainty due to rapid population growth created challenges for local and state governments.

On a related note, industry's lack of transparency was another common issue for communities. At the landowner scale, in chapter four, farmers and ranchers described signing leases with little information and, in worst case scenarios, did not have accurate

contact information for when pipeline problems arose. In chapter seven, transportation decision makers had to prioritize which roads to upgrade and where to site new roads, often with little information about where industry was planning to drill in the future. Pre-emptive planning and mitigation were nearly impossible. Sometimes they guessed correctly, and sometimes not – as demonstrated by the Killdeer bypass which is largely unused since industry moved to a new “hot spot” for drilling before its completion. The lack of data and the general uncertainty associated with UOG booms amplifies burdens for decisionmakers, landowners, and residents during a time already marked by rapid growth and stress.

UOG Is a Distinct Geography of Public Finance

In addition to the UOG creating distinct regional geographies of production, the industry also creates distinct geographies of public finance. From a macroeconomic perspective, the economies in geographies with UOG act counter-cyclically to other regions. When oil prices are high, most of the US experiences an economic downturn; however, in the Bakken, high prices result in substantial economic growth and large increases in tax revenues. This section argues that the UOG development in resource peripheries creates a distinct geography of public finance. It highlights two defining features. First, the UOG industry demands a level of accommodation and subsidization from local communities that is not typical with many other industries. Second, UOG creates an ever-present risk of dependence that communities must actively work to avoid.

Local Subsidies Enable UOG

While there is a rich literature on the socio-economic impacts of energy boomtowns stemming from the 1970s (e.g., Gilmore 1976; Wilkinson 1982), a comprehensive assessment of UOG's costs and benefits has been challenging to create due to regulatory, economic, geographic, and geologic differences between regions. In the short term, UOG generally prompts short-term economic benefits from job creation and increases in tax revenues (Raimi 2017). However, UOG also creates significant incidental costs to communities, landowners, and governments. These range from cost increases in land, labor, and other inputs (Barth 2013; Ellis et al. 2016) to increased government expenditures (Olien and Olien 1982; Smith et al. 2019; Smith and Haggerty 2020) to reclamation problems (Smith and Haggerty 2018), amongst others. Whether or not benefits from UOG outpace costs is often debated (e.g., Krupnick, Echarte, and Muehlenbachs 2017). The findings from my dissertation demonstrate that local communities accommodate and subsidize industry in ways that are often unaccounted for in these cost-benefit assessments.

As argued in chapter seven, cost shifting is a defining feature of regions with UOG development. To function, the UOG needs ready access to public infrastructure. Simultaneously, its impacts on public infrastructure are disproportionately large, from damaging roads to increasing demands beyond capacity on landfills, airports, wastewater and freshwaters systems, and emergency services. At the local scale, the costs of building and maintaining this infrastructure are socialized onto the public while the revenues from industry are privatized. State and local governments that do not have sufficient funds to address UOG impacts may re-shift industry's costs onto other governments, further

distorting and complicating the distribution of industry's costs throughout the region. How the industry's needs are addressed and funded by local and state governments has important consequences for the long-term fiscal health of regions with UOG development.

As rapid UOG development stretches local communities' capacities, government employees and elected officials often expend a significant amount of their personal time accommodating industry. In the public sector, local governments must rapidly transform their services and infrastructure to accommodate influxes of workers and industrial traffic. Government officials and employees often work substantial overtime hours in the process. When discussing how the city was able to receive \$300 million from the state Department of Transportation to address road needs, one interviewee explained:

I'll say if anything the people that put in many hours that probably were never rewarded were those local elected officials. And that occurred with counties as well. The typical county meetings became almost day meetings just dealing with issues.

As in many rural regions, many of the Bakken's government positions are volunteer positions. The hidden labor that enables UOG is a significant, though often overlooked, form of cost shifting that makes the Bakken a distinct geography of public finance.

The Status Quo Reinforces Dependence

This dissertation demonstrates that communities and states must actively adapt their fiscal policies to avoid becoming economically dependent on UOG. The infrastructure investments described in this dissertation were critical in addressing UOG impacts. However, many of them were designed to stabilize industry as opposed to creating new opportunities for economic diversification, a tension previously described

by Ryser et al. (2019). Investing in projects that reinforce the status quo for industry creates a risk of stranded assets if industry leaves (Argent 2016). The risk of over-adaptation is clear in the Bakken, as many infrastructure investments were built to accommodate industrial needs and will be hard to repurpose if the UOG industry declines.

Notably, North Dakota's Legacy Fund is a progressive fiscal policy that was created specifically to capture long-term benefits from the boom. Western North Dakota legislators recognized the need to save and invest a portion of its oil and gas tax revenues as opposed to allocating it to general operating funds. The state established the Legacy Fund in 2010, and 30 percent of oil and gas revenues are deposited into the account. As of August 31, 2020, the account's principal balance was \$6.2 billion (North Dakota Retirement and Investment Office 2020). While the Legacy Fund is critical for leveraging the boom's benefits into the future, it was not designed to stabilize or protect local budgets from the volatility of the global oil market (Haggerty 2020). Consequently, many local communities still struggle whenever oil prices dip, creating unnecessary uncertainty and complicating future planning efforts.

At the local level, governments typically experience massive increases in revenue from UOG activity and will become dependent on this volatile funding unless they actively avoid it. With few fiscal mechanisms to save money at the local level, governments often treat revenue dependent on UOG development, including sales tax revenue, as general operating revenue. They often become increasingly reliant on it for day-to-day expenses. Further, communities with increased revenues from sales taxes and

state tax redistributions may be tempted to cut property taxes or rely more heavily on sales taxes. For instance, the Williston Area Recreation Center (chapter four) was funded through a sales tax that replaced the park district's previous property tax allotment. This substituted a stable funding mechanism (the property tax) for a volatile source (the sales tax). The fiscal risk is substantial. Revenues reliant on UOG development are notoriously volatile. During the slowdown in oil production between 2014 and 2016, the cities of Williston, Dickinson, Watford City, Stanley, Tioga, and Killdeer experienced an average 47% drop in their local sales tax revenue (AE2S 2017). If and when UOG declines, budgets that rely on sales taxes and other revenue streams dependent on industry will likely experience shortfalls. Further, when communities become overly reliant on direct and indirect UOG revenues for general operating money they entrench economic dependence on resource extraction. The risk of dependence is an ever-present factor in regions with UOG that sets these geographies apart from other regions with more diversified economic portfolios.

Debt is another characteristic that makes UOG regions distinct geographies of public finance. When industry overwhelms local infrastructure, governments may fund new projects and/or upgrades with loans and bonds that are backed with revenue sources reliant on continued oil and gas development. Rural and remote communities with limited pre-existing infrastructure are particularly at risk for large debt loads. For instance, the Western Area Water Supply project team circumvented traditional state water funding mechanisms and opted to take out loans backed by revenue from industrial water sales. When UOG activity declined, it imperiled the Authority's ability to repay loans and

forced the team to consolidate loans and re-negotiate terms with the state. While the risks of resource-backed loans have been discussed in the context of loans in Africa and the Global South (e.g., Mihalyi, Adam, and Hwang 2020), domestic loans in the United States backed with indirect revenues from oil and gas development have received far less attention. In the Bakken, debt is often taken on with the assumption that UOG will continue to generate significant local revenues, though the volatility of oil and gas prices make this assumption questionable.

Current fiscal policies in North Dakota do not insulate the region from economic dependence on UOG. When dependence occurs, communities are often less likely to accept economic transitions or support policies that may limit resource extraction (Haggerty 2020). This dissertation demonstrates that public infrastructure investments at times can reinforce dependence, but this risk is often unacknowledged by state and local decisionmakers. Infrastructure investments therefore have important long-term consequences for how western North Dakota is able to reinvent itself when UOG development ends. In this light, infrastructure investments and their funding strategies are critical components of understanding future economic trajectories and planning for resilient futures. These concerns illustrate the unique fiscal challenges of regions that host UOG and speak to the need to treat them as distinct geographies of public finance.

Future Research: Proposing a Geography of Public Finance Approach

This dissertation's most novel contribution is to assert that regions with UOG development are distinct geographies of public finance. Public works projects are important investments that create new landscapes for enabling oil and gas investment and

development. However, as Harvey (2001) argued, the contradictions between the nimbleness of capital and the fixed materiality of infrastructure investments are ripe for local mismatches that can prompt regional (or potentially global) crises. Thus, this dissertation takes infrastructure investments seriously. They are simultaneously an opportunity and a threat, a chance for transformation and a risk for entrenching dependence. They are part of a distinct geography of public finance that has hitherto been largely unexplored.

More research is needed to understand how UOG development shapes public finances and public finances shape UOG development. Thus, this dissertation ends by providing a framework (Figure 8.1) for a potential approach for investigating geographies of public finance in the context of UOG development. It builds upon Bennett's (1980) conceptualization of a geography of public finance as being concerned with the spatial distribution of tax revenues and government expenditures. This dissertation's research findings offer important additions to the framework. For instance, this dissertation demonstrates that opportunity costs in regions with UOG development – including the revenues not raised, the future maintenance costs not budgeted, the savings not saved, and the costs not spent – can have critical implications for communities' ability to avoid economic dependence. Opportunity costs are included in this framework to draw attention to their importance. Notably, opportunity costs are not always quantifiable. Analyzing geographies of public finance would thus demand a qualitative approach in addition to quantitative data. Barnes and Hayter's (2005) "local model" strategy

foregrounds the messiness of economic dependence, offering a promising approach for incorporating historical, political, and social variables into public finance studies.

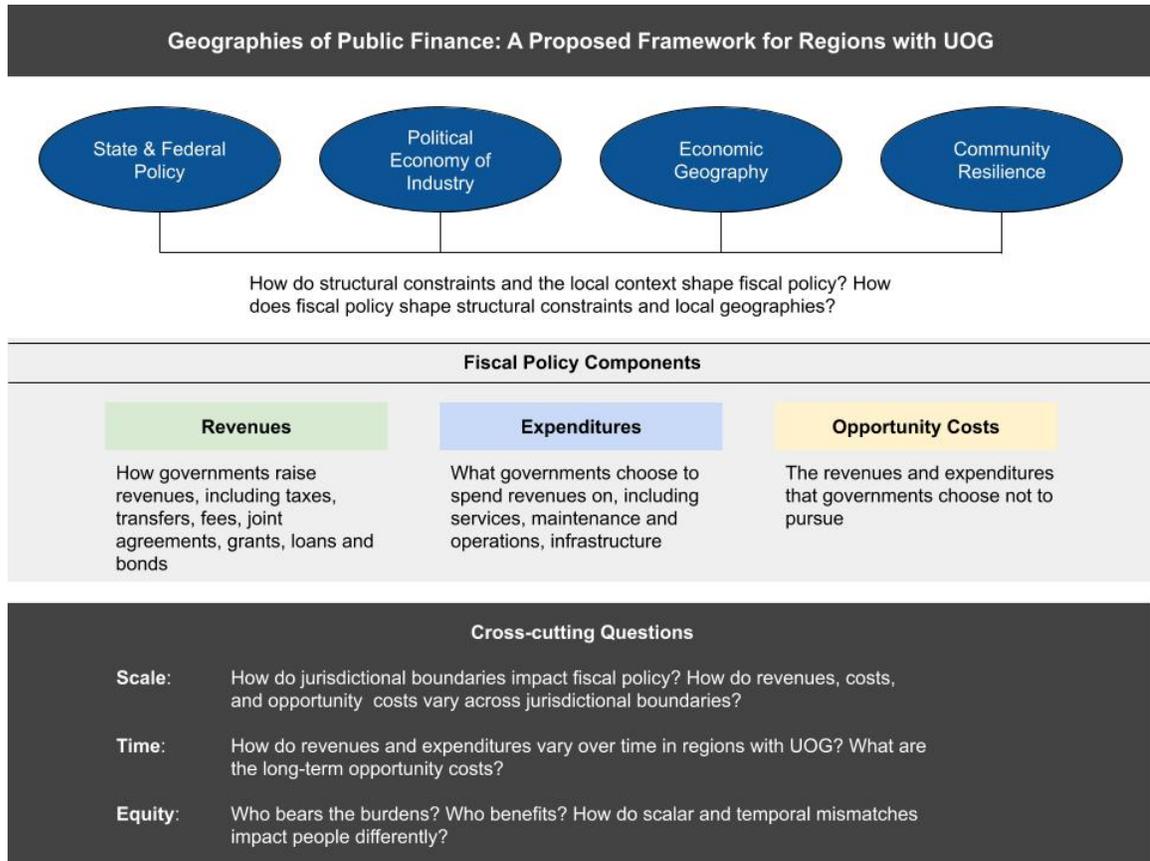


Figure 8.1. A proposed framework for analyzing geographies of public finance.

A geography of public finance framework, when applied to regions like the Bakken, complicates assumptions about boomtowns and provides more nuanced understandings of how economic dependence forms “on the ground.” It would shed light on the opaque systems underlying UOG development, responding to Bridge’s (2009) call for researchers to articulate the “work” and mundane processes that enable resource development. Further, this approach builds from the economic geography scholarship on

resource peripheries and economic dependence by grounding ideas about path dependency, exported benefits, and economic over-adaptation into implications for local governments' finances.

The framework in Figure 8.1 is offered as a prompt for future research. It is the beginning of an idea. More work is needed to refine this approach's theoretical underpinnings and identify the methods, tools, and data needed to understand the distinct fiscal needs of regions with UOG development. Given the lack of coherent state and local government finance databases and the data gaps surrounding the UOG industry, data challenges will need to be collectively problem solved by researchers. Nonetheless, my hope is that this proposed framework sparks ideas for how to better assess the short- and long-term impacts of UOG development on states, regions, and communities.

A Final Word: COVID-19 and the Collapse of Oil Markets

In mid-April 2020, for the first time in history, futures prices for crude oil plummeted to negative numbers (Halkias 2020; Reed and Krauss 2020). The market crash resulted from sharp decreases in demand due to impacts from the global COVID-19 pandemic and a global oversupply of oil and shortages in storage capacity (Reed and Krauss 2020). In the United States, the collapse of global oil markets created a crisis within a crisis for regions dependent on UOG. Since UOG development is highly responsive to global oil markets, operations screeched to a halt across the country, resulting in bankruptcies, pay cuts, and layoffs in the UOG industry (Lee 2020a).

In North Dakota, troubles in the oil fields predated the market crash, with Whiting Petroleum Company – one of the region's top crude oil producers – declaring bankruptcy

on April 1 (Hagen 2020). Other companies have followed suit, and overall production in the state dropped a record 350,000 barrels per day between April to May (Lee 2020b). Since the beginning of the year, North Dakota’s oil service sector lost 11,100 jobs (Helms 2020). The industry’s decline has direct consequences on the state’s fiscal wellbeing. Since 2009, oil revenues have ranged from 17 to 24 percent of the state’s general operating fund – a significant source. As Figure 8.2 demonstrates, the state’s oil and gas revenues fell below projections beginning in March due to impacts from the pandemic. State leaders are planning for 16 to 50 percent decreases in total revenues (Jackson 2020), and – not surprisingly – Governor Doug Burgum has asked agency leaders to be prepared to cut their budgets between 5 and 15 percent for the 2021 legislative session (Burgum 2020). Put bluntly, the state is very dependent on UOG development, and the crash in oil prices represents a fiscal crisis.

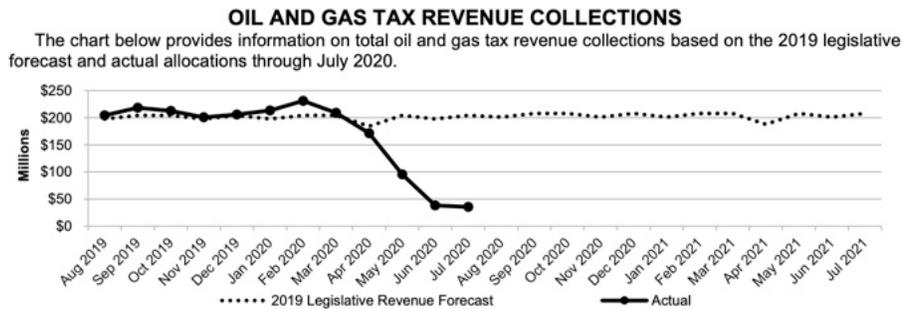


Figure 8.2. Projected oil and gas tax revenues versus actual revenues, 2019 – 2021.

At the local scale, COVID-19’s impacts will be felt more acutely in the Bakken. Figure 8.3 illustrates how oil production has increased and decreased in North Dakota’s top four oil-producing counties since the boom began in 2006. Each of the counties experienced a sharp decline in May and June 2020. When compared to each county’s

historic peak month, Dunn County experienced the largest decline in June 2020 (55%) followed by McKenzie and Williams Counties (both at 46%) and then Mountrail County (41%)⁶. As this dissertation has discussed, local governments often rely on oil and gas revenues and associated increases in sales taxes to back loans, fund infrastructure investments, and pay for operations and maintenance. The impacts from COVID-19 contribute additional layers of uncertainty that local and state governments must grapple with as they problem-solve revenue declines and continue to try to leverage UOG into long-term benefits.

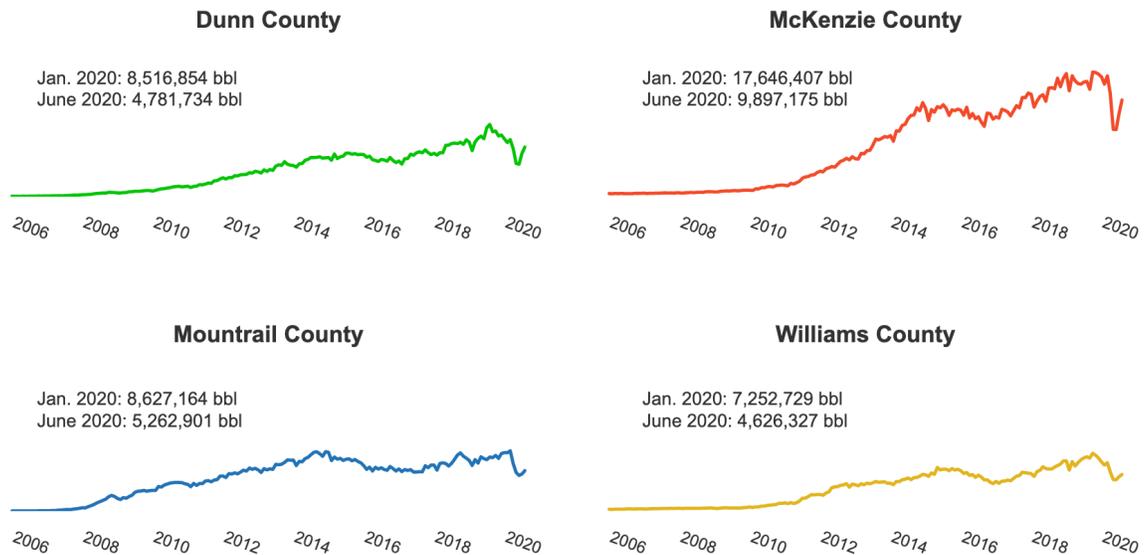


Figure 8.3. Monthly oil production by county, 2006 – 2020.

⁶ Dunn County peak production: August 2019 at 10,637,007 barrels. McKenzie County peak production: October 2019 at 18,356,118 barrels. Mountrail County peak production: March 2020 at 8,886,463 barrels. Williams County peak production: October 2019 at 8,526,964 barrels.

COVID-19 is a dramatic and worrying end to this dissertation. A “V-shaped” recession with a short shock and quick recovery seems increasingly unlikely, and the consequences for oil-dependent communities will be challenging without state and federal assistance. Economic transitions are hard when they are slow and planned. The collapse of the UOG industry was sudden, and the impacts were felt immediately at the local scale. These are not ideal circumstances for transitions. As western North Dakota tries to recover, it is unclear the extent to which oil will rebound. In a recent discussion about the future of oil, Lynn Helms, North Dakota’s Director of the Department of Mineral Resources, emphasized “*if we ever fully recover*” it will not be for at least several years (Helms 2020).

Although COVID-19 is an extreme economic shock, it demonstrates the importance of this research and the need for additional research on how communities can maximize benefits from energy development and avoid dependence. The longer the pandemic continues, the more likely it is that regions dependent on UOG will struggle to maintain infrastructure investments, make debt payments, and continue to provide government services at their current level. As shown by this dissertation, local leaders are often incredibly creative during times of crisis. Yet, when the magnitude of the crisis overwhelms their capacity – as is likely with COVID-19 – there is little that can be done at the local level to address broader structural problems.

Current UOG regulations and fiscal policies are failing communities in the Bakken. The pandemic is an opportunity to transform policies to meet the needs of communities in regions with UOG development. Solutions should focus on providing

stable and predictable revenues to local governments, reinvesting earnings from the Legacy Fund into North Dakota projects, and incentivizing regional collaborations. These strategies would build local capacity and allow for more strategic planning. This dissertation demonstrates the need to empower local communities to direct their own future with the coordinated support from regional, state, and federal entities. COVID-19 is an opportunity to rethink the nation's relationships with its resource peripheries and help leverage their resource abundance into long-term benefits.

References Cited in Chapter Eight

- AE2S Nexus the Financial Link. 2017. Six cities impacts forecasting: executive summary. Energy Impact Presentation, Bismarck, ND, January 9.
<https://econdev.mckenziecounty.net/usrfiles/EnergyImpactStudyPresentation-ae2s.pdf>
- Argent, N. 2016. Australia – trap or opportunity? Natural resource dependence, scale, and the evolution of new economies in the space/time of New South Wales’ Northern Tablelands. In *Transformation of resource towns and peripheries*, ed. G. Halseth, 18–50. New York: Routledge.
- Barnes, T. J., and R. Hayter. 2005. No “Greek-letter writing”: local models of resource economies. *Growth and Change* 36 (4): 453–70.
- Barth, J. M. 2013. The economic impact of shale gas development on state and local economies: benefits, costs, and uncertainties. *New Solutions: A Journal of Environmental and Occupational Health Policy* 23 (1): 85–101.
- Bennett, R. J. 1980. The geography of public finance: welfare under fiscal federalism and local government finance. Vol. 815. New York: Routledge.
- Bridge, G. 2009. Material worlds: natural resources, resource geography, and the material economy. *Geography Compass* 3 (3): 1217–44.
- Burgum, D. 2020. Burgum presents strategic budget guidelines for 2021-2023 biennium. North Dakota Office of the Governor, May1.
<https://www.governor.nd.gov/news/burgum-presents-strategic-budget-guidelines-2021-2023-biennium>.
- Cameron, P. D., and M. C. Stanley. 2017. *Oil, gas, and mining: a sourcebook for understanding the extractive industries*. Washington, DC: The World Bank.
- Ellis, C., G. L. Theodori, P. Petrzela, D.s Jackson-Smith, and A. E. Luloff. 2016. Unconventional risks: the experience of acute energy development in the Eagle Ford Shale. *Energy Research & Social Science* 20: 91–8.
- Gilbertz, S. J., M. B. Anderson, and J. M. Adkins. 2020. The Bakken blind field: investigating planetary urbanization and opaqueness in the oil and gas fields of eastern Montana. *Annals of the American Association of Geographers*: 1–18.
- Gilmore, J. S. 1976. Boom towns may hinder energy resource development. *Science* 191 (4227): 535–40.

- Hagen, E. 2020. Whiting Petroleum Corporation reaches agreement in principle with certain of its noteholders to pursue consensual financial restructuring. News Release, Whiting Petroleum Corporation, Denver, CO, April 1. <https://www.sec.gov/Archives/edgar/data/1255474/000119312520093737/d899645dex992.htm>.
- Haggerty, M. 2020. *How fiscal policy is failing rural America*. Headwaters Economics, Bozeman, MT.
- Halkias, M. 2020. Oil prices fall to historic lows as West Texas crude futures drop below \$0. *The Dallas Morning News*, April 20. With contributions from C. Ngai, O. Raimonde, and A. Longley of Bloomberg News. <https://www.dallasnews.com/business/energy/2020/04/20/oil-prices-fall-to-historic-lows-as-west-texas-crude-futures-go-negative/>.
- Harvey, D. 2001. *Spaces of capital: towards a critical geography*. New York: Routledge.
- Helms, L. 2020. Oil industry outlook. Western Dakota Energy Association Annual Meeting, October 16. <https://www.youtube.com/watch?v=NAwSee9N1cE>.
- Jackson, J. 2020. Economic outlook: a forecast of the effect of COVID-19 on North Dakota. Center for the Study of Public Choice and Private Enterprise, North Dakota State University, Fargo. https://www.ndsu.edu/fileadmin/centers/pcpe/Economic_Outlook/EO_Covid19.pdf.
- Jacquet, J. B. 2014. Review of risks to communities from shale energy development. *Environment Science & Technology* 48 (15): 8321–33.
- Jacquet, J. B., and D. L. Kay. 2014. The unconventional boomtown: updating the impact model to fit new spatial and temporal scales. *Journal of Rural and Community Development* 9 (1): 1–23.
- Jacquet, J. B., K. Witt, W. Rifkin, and J. H. Haggerty. 2018. A complex adaptive system or just a tangled mess? Property rights and shale gas governance in Australia and the US. In *Governing Shale Gas*, ed. J. Whitton, M. Cotton, I. M. Charnley-Parry, and K. Brasier, 55–68. New York: Routledge.
- Jean, R. 2018. Royalty owners questioning deductions. *Williston Herald*, October 9. https://www.willistonherald.com/news/royalty-owners-questioning-deductions/article_163985d2-cb43-11e8-990b-f73131ec6d64.html.
- Keough, S. B. 2015. Planning for growth in a natural resource boomtown: challenges for urban planners in Fort McMurray, Alberta. *Urban Geography* 36 (8): 1169–96.

- Krupnick, A. J., I. Echarte, and L. Muehlenbachs. 2017. Local government impacts of unconventional oil and gas. *The Community Impacts of Shale Gas and Oil Development, Resources for the Future*, Washington, DC. https://media.rff.org/archive/files/document/file/RFF-Rpt-ShaleReviews_LocalGovt_0.pdf.
- Lee, M. 2020a. “Brutal”: 100k jobs lost as rig count hits all-time low. *E&E News*, June 15. <https://www.eenews.net/energywire/stories/1063389519/>.
- Lee, M. 2020b. A five-alarm fire for North Dakota’s oil and gas industry. *E&E News*, July 20. <https://www.eenews.net/energywire/2020/07/20/stories/1063593773>.
- Malin, S. A., T. Opsal, T. O’Connor Shelley, and P. M. Hall. 2019. The right to resist or a case of injustice? Meta-power in the oil and gas fields. *Social Forces* 97 (4): 1811–38.
- Measham, T. G., D. A. Fleming, and H. Schandl. 2016. A conceptual model of the socioeconomic impacts of unconventional fossil fuel extraction. *Global Environmental Change* 36: 101–10.
- Mihalyi, D., A. Adam, and J. Hwang. 2020. Resource-backed loans: pitfalls and potential. Natural Resource Governance Institute, New York, NY.
- Morrison, T. H. 2016. The meta-governance of regions and the need for a political geography of planning. *International Planning Studies* 21 (3): 298–304.
- North Dakota Job Service. 2020. North Dakota monthly unemployment initial claims. Labor Market Information. Accessed October 18, 2020. <https://www.ndlmi.com/gsipub/index.asp?docid=687>.
- North Dakota Retirement and Investment Office. 2020. Legacy fund. Accessed October 22, 2020. <https://www.rio.nd.gov/legacy-fund>.
- Olien, R. M., and D. D. Olien. 1982. *Oil booms: social change in five Texas towns*. Lincoln: University of Nebraska Press.
- Raimi, D. 2017. *The fracking debate: the risks, benefits, and uncertainties of the shale revolution*. New York: Columbia University Press.
- Reed, S., and C. Krauss. 2020. Too much oil: how a barrel came to be worth less than nothing. *The New York Times*, April 20. Updated April 27, 2020. <https://www.nytimes.com/2020/04/20/business/oil-prices.html>.
- Robbins, P. 2012. *Political ecology*. 2nd ed. Vol. 16. West Sussex, UK: John Wiley & Sons.

- Russell, E. 2019. The first new US airport since 2011 is in North Dakota's oil country. The Points Guy. Accessed October 25, 2020. <https://thepointsguy.com/news/the-first-new-us-airport-since-2010-is-in-north-dakotas-oil-country/>.
- Ryser, L., G. Halseth, S. Markey, C. Gunton, and N. Argent. 2019. Path dependency or investing in place: understanding the changing conditions for rural resource regions. *The Extractive Industries and Society* 6 (1): 29–40.
- Small, M. J., P. C. Stern, E. Bomberg, S. M. Christopherson, B. D. Goldstein, A. L. Israel, R. B. Jackson, A. Krupnick, M. S. Mauter, J. Nash, et al. 2014. Risks and risk governance in unconventional shale gas development. *Environmental Science & Technology* 48 (15): 8289–97.
- Smith, K. K., and J. H. Haggerty. 2018. Devolved governance & alternative dispute resolution programs: An example from the Bakken. In *Governing shale gas: Development, citizen participation and decision making in the US, Canada, Australia and Europe*, ed. K. Brasier, M. Cotton, and J. Whitton, 184–97. London: Routledge.
- Smith, K. K., and J. H. Haggerty. 2020. Exploitable ambiguities and the unruliness of natural resource dependence: public infrastructure in North Dakota's Bakken Shale Formation. *Journal of Rural Studies*. <https://doi.org/10.1016/j.jrurstud.2020.05.006>.
- Smith, K. K., J. H. Haggerty, D. L. Kay, and R. Coupal. 2019. Using shared services to mitigate boomtown impacts in the Bakken Shale Play: resourcefulness or over-adaptation? *Journal of Rural and Community Development* 14 (2): 66–86.
- Walsh, K. B., and J. H. Haggerty. 2020. Social license to operate during Wyoming's coalbed methane boom: implications of private participation. *Energy Policy* 138: 111217.
- Warner, M. 2017. Lessons learned from ICMA's alternative service delivery survey. Paper presented at the 2017 ICMA Conference, San Antonio, TX, October 23.
- Wilkinson, T. 1982. Environmental programme for offshore oil operations. *Chemistry and Industry* 4: 115–23.
- Ziogiannis, N., J. Alcorn, J. Rupp, S. Carley, and J. D. Graham. 2016. State regulation of unconventional gas development in the US: an empirical evaluation. *Energy Research & Social Science* 11: 142–54.

REFERENCES CITED

- Abramzon, S., C. Samaras, A. Curtright, A. Litovitz, and N. Burger. 2014. Estimating the consumptive use costs of shale natural gas extraction on Pennsylvania roadways. *Journal of Infrastructure Systems* 20 (3).
- Adger, N. 2000. Social and ecological resilience: are they related? *Progress in Human Geography* 24: 347–64.
- AE2S Nexus the Financial Link. 2017. Six cities impacts forecasting: executive summary. Energy Impact Presentation, Bismarck, ND, January 9. <https://econdev.mckenziecounty.net/usrfiles/EnergyImpactStudyPresentation-ae2s.pdf>.
- Alberta Energy Regulator. 2013. Alternative dispute resolution program and guidelines for energy industry disputes. Manual 004. <http://aer.ca/documents/manuals/Manual004.pdf>.
- Alberta Energy Regulator. 2016. 2015/2016 annual report. Calgary. <http://www.aer.ca/documents/reports/AER2015-16AnnualReport.pdf>.
- Allred B. W., W. K. Smith, D. Twidwell, J. H. Haggerty, S. W. Running, D. E. Naugle, and S. D. Fuhlendorf. 2015. Ecosystem services lost to oil and gas in North America. *Science* 348: 401–2. doi:10.1126/science.aaa4785.
- Anderies, J. M., M. A. Janssen, and E. Ostrom. 2004. A framework to analyze the robustness of social-ecological systems from an institutional perspective. *Ecology and Society* 9 (1): 18.
- Appel, H., A. Mason, and M. Watts. 2015. Introduction: oil talk. In *Subterranean estates: life worlds of oil and gas*, ed. H. Appel, A. Mason, and M. Watts, 1–26. Ithaca, NY: Cornell University Press.
- Appel, H., N. Anand, and A. Gupta. 2018. Introduction: temporality, politics, and the promise of infrastructure. In *The promise of infrastructure*, ed. N. Anand, A. Gupta, and H. Appel, 1–40. Durham, NC: Duke University Press.
- Argent, N. 2013. Reinterpreting core and periphery in Australia’s mineral and energy resources boom: an Innisian perspective on the Pilbara. *Australian Geographer* 44 (3): 323–40.
- Argent, N. 2016. Australia – trap or opportunity? Natural resource dependence, scale, and the evolution of new economies in the space/time of New South Wales’ Northern Tablelands. In *Transformation of resource towns and peripheries*, ed. G. Halseth, 18–50. New York: Routledge.
- Argent, N. 2017. Rural geography I: resource peripheries and the creation of new global commodity chains. *Progress in Human Geography* 41 (6): 803–12.

- Balliet, K. 2008. Should you join a landowner group? Penn State Extension, State College, PA. Retrieved from <http://extension.psu.edu/natural-resources/natural-gas/issues/leases/publications/should-you-join-a-landowner-group>.
- Barnes, T. J., and B. Christophers. 2018. *Economic geography: a critical introduction*. Hoboken, NJ: John Wiley & Sons.
- Barnes, T. J., and R. Hayter. 2005. No “Greek-letter writing”: local models of resource economies. *Growth and Change* 36 (4): 453–70.
- Barnes, T. J., R. Hayter, and E. Hay. 2001. Stormy weather: cyclones, Harold Innis, and Port Alberni, BC. *Environment and Planning A* 33 (12): 2127–47.
- Barth, J. M. 2013. The economic impact of shale gas development on state and local economies: benefits, costs, and uncertainties. *New Solutions: A Journal of Environmental and Occupational Health Policy* 23 (1): 85–101.
- Becker, K. L. 2016. The paradox of plenty: blessings and curses in the oil patch. In *The Bakken goes boom*, ed. K. Conway and W. Caraher, 11–30. Grand Forks: Digital Press at the University of North Dakota.
- Bennett, R. J. 1980. The geography of public finance: welfare under fiscal federalism and local government finance. Vol. 815. New York: Routledge.
- Berg, B. L., and H. Lune. 2004. *Qualitative research methods for the social sciences*. Upper Saddle River, NJ: Pearson Education.
- Berkes, F., and H. Ross. 2013. Community resilience: toward an integrated approach. *Society & Natural Resources* 26 (1): 5–20.
- Berwick, M., K. Vachal, K. Johnson, and J. Baker. 2010. County road survey for Transportation Managers. Rural Transportation Safety and Security Center at the Upper Great Plains Transportation Institute, North Dakota State University, Fargo. <https://www.ugpti.org/resources/reports/downloads/dp-238.pdf>.
- Besser, T. L. 2013. Resilient small rural towns and community shocks. *Journal of Rural and Community Development* 8 (1): 117–34.
- Besser, T. L., N. Recker, and K. Agnitsch. 2008. The impact of economic shocks on quality of life and social capital in small towns. *Rural Sociology* 73 (4): 580–604.
- Blaikie, P. 1985. *The political economy of soil erosion in developing countries*. London: Longman.
- Bogart, B. 2019. How the oil industry and region benefit and support the state: oil and gas tax revenues. Jadestone Consulting, compiled for North Dakota Petroleum

Council and the Western Dakota Energy Association, Bismarck, ND.
<https://taxstudy.ndenergy.org/TaxStudy>.

- Bouzarovski, S., M. Bradshaw, and A. Wochnik. 2015. Making territory through infrastructure: the governance of natural gas transit in Europe. *Geoforum* 64: 217–28.
- Brasier, K. J., M. R. Filteau, D. K. McLaughlin, J. Jacquet, R. C. Stedman, T. W. Kelsey, and S. J. Goetz. 2011. Residents' perceptions of community and environmental impacts from development of natural gas in the Marcellus Shale: a comparison of Pennsylvania and New York cases. *Journal of Rural Social Sciences* 26 (1): 32.
- Brasier, K., L. Davis, L. Glenna, T. Kelsey, D. McLaughlin, K. Schafft, K. Bobbie, C. Biddle, A. Delessio-Parson, and D. Rhubarb. 2014. The Marcellus Shale impacts study: chronicling social and economic change in North Central and Southwest Pennsylvania. Center for Rural Pennsylvania, Harrisburg, PA.
- Bratlien, A., A. Dybing, L. Holt, T. Horner, Y. Kazemi, E. Lee, P. Lu, J. Mielke, D. Tolliver, B. Wentz, V. Dang, C. DeHaan, N. Dharmadhikari, C. Ifepe, Y. Shin Park, F. Yuan, and Z. Zheng. 2014. Infrastructure Needs: North Dakota's County, Township and Tribal Roads and Bridges: 2015-2034. Report for the North Dakota Legislative Assembly. Upper Great Plains Transportation Institute, North Dakota State University, Fargo, ND.
- Bridge, G. 2009. Material worlds: natural resources, resource geography, and the material economy. *Geography Compass* 3 (3): 1217–44.
- Bridge, G. 2018. The map is not the territory: a sympathetic critique of energy research's spatial turn. *Energy Research and Social Science* 36: 11–20.
- Bridge, G., and T. Perreault. 2009. Environmental governance. In *A companion to environmental geography*, ed. N. Castree, D. Demeritt, D. Liverman, and B. Rhoads, 475–97. Oxford: Blackwell.
- Bridge, G., and P. Le Billon. 2017. *Oil*. 2nd ed. Malden, MA: Polity Press.
- Bridge, G., J. McCarthy, and T. Perreault. 2015. *Editors' introduction*. In *The Routledge handbook of political ecology*, ed. T. Perreault, G. Bridge, and J. McCarthy, 3–18. New York: Routledge.
- Burgum, D. 2020. Burgum presents strategic budget guidelines for 2021-2023 biennium. North Dakota Office of the Governor, May 1.
<https://www.governor.nd.gov/news/burgum-presents-strategic-budget-guidelines-2021-2023-biennium>.

- Buse, C. G., M. Sax, N. Nowak, J. Jackson, T. Fresco, T. Fyfe, and G. Halseth. 2019. Locating community impacts of unconventional natural gas across the supply chain: a scoping review. *The Extractive Industries and Society* 6 (2): 620–9.
- Calvert, K. 2016. From “energy geography” to “energy geographies”: perspectives on a fertile academic borderland. *Progress in Human Geography* 40 (1): 105–25.
- Cameron, P. D., and M. C. Stanley. 2017. *Oil, gas, and mining: a sourcebook for understanding the extractive industries*. Washington, DC: The World Bank.
- Carlson, R. L. and L. J. Sprunk. 1979. *History of the North Dakota State Highway Department*. North Dakota State Highway Department, Bismarck, North Dakota.
- Carpenter, S. R., B. H. Walker, J. M. Anderies, and N. Abel. 2001. From metaphor to measurement: resilience of what to what? *Ecosystems* 4: 765–81.
- Carse, A. 2014. *Beyond the big ditch: politics, ecology, and infrastructure at the Panama Canal*. Cambridge, MA: MIT Press.
- Carse, A., and J. A. Lewis. 2017. Toward a political ecology of infrastructure standards: or, how to think about ships, waterways, sediment, and communities together. *Environment and Planning A* 49 (1): 9–28.
- Chambers, C. 2020. Beneath the surface: capital-labor relations, housing and the making of the Bakken boom. *The Extractive Industries and Society* 7 (3): 908–17.
- Christopherson, S. 2012. How should we think about the economic consequences of shale gas drilling? Paper presented at the Environmental and Social Implications of Hydraulic Fracturing and Gas Drilling in the United States: An Integrative Workshop for the Evaluation of the State of Science and Policy, Duke University, Durham, NC, January 9. <http://kansas.sierraclub.org/wp-content/uploads/2014/01/Duke-Presentation-Christopherson.pdf>.
- City of Dickinson. 2013. Dickinson 2035: roadmap to the future. Transportation master plan. Prepared by KLJ.
- Clark, L., M. Lee, and C. Anchondo. 2020. Head-scratching at the White House as oil crash continues. *E&E News*, April 22. <https://www.eenews.net/energywire/stories/1062938449/search?keyword=negative+oil+price>.
- Coe, N. M., P. F. Kelly, and H. W. C. Yeung. 2020. *Economic geography: a contemporary introduction*. Hoboken, NJ: John Wiley & Sons.

- Connelly, S. and E. Nel. 2016. Restructuring of the New Zealand economy: global-local links and evidence from the west coast and southland regions. In *Transformation of resource towns and peripheries*, ed. G. Halseth, 136–60. New York: Routledge.
- Corbin, J., and A. Strauss. 2008. *Qualitative research*. Thousand Oaks, CA: Sage.
- Cretney, R. 2014. Resilience for whom? Emerging critical geographies of socio-ecological resilience. *Geography Compass* 8/9: 627–40.
- Cummings, R. G., and A. F. Mehr. 1977. Investments for urban infrastructure in boomtowns. *Natural Resources Journal* 17.
- de Souza, S. V., B. Dollery, and B. Blackwell. 2018. An empirical analysis of mining costs and mining royalties in Queensland local government. *Energy Economics* 74: 656–62.
- Donovan, L. 2015. Highway 85 leads deadly statistics. *Bismarck Tribune*, February 14. https://bismarcktribune.com/bakken/highway-85-leads-deadly-statistics/article_3651cf63-28e9-5ac2-ad91-c75699e03088.html.
- Drache, D. 1995. Celebrating Innis: the man, the legacy, and our future. In *Staples, markets, and cultural change: selected essays*, ed. H. A. Innis and D. Drache, xiii–lix. Montreal: McGill-Queen’s University Press.
- Drew, J., B. E. Dollery, and B. D. Blackwell. 2018. A square deal? Mining costs, mining royalties and local government in New South Wales, Australia. *Resources Policy* 55: 113–22.
- Dybing, A. G. 2012. Estimation of increased traffic on highways in Montana and North Dakota due to oil development and production. PhD diss., North Dakota State University of Agriculture and Applied Science.
- Dybing, A. 2018. Local transportation funding sources. Paper presented at North Dakota Symposium on Transportation Funding, Upper Great Plains Transportation Institute, Bismarck, ND, March 14. <https://www.dot.nd.gov/public/docs/fundingsymposium/ND%20Local%20Funding%20Sources%20UGPTI%20presentation.pdf>.
- Dybing, A., P. Lu, D. Heglund, T. Horner, M. Jaroszynski, T. Jirik, B. Wentz, A. Wrucke, L. Holt, C. DeHaan, Y. Shin Park, P. Kayabas, Y. Xu, O. Khan, F. Yuan, A. R. Taleqani, Z. Zheng, and C. Ifepe. 2016. Infrastructure needs: North Dakota’s county, township and tribal roads and bridges: 2017–2036. Report for the North Dakota Legislative Assembly. Upper Great Plains Transportation Institute, North Dakota State University, Fargo, ND.

- Dybing, A., P. Lu, D. Heglund, T. Horner, T. Jirik, B. Wentz, K. Bengtson, S. S. Wadhwa, N. Dhingra, and S. Hasan. 2020. Infrastructure needs: North Dakota's county, township and tribal roads and bridges: 2021–2040. Report for the North Dakota Legislative Assembly. Upper Great Plains Transportation Institute, North Dakota State University, Fargo, ND.
- Ellingson, L. L. 2009. *Engaging crystallization in qualitative research: an introduction*. Thousand Oaks, CA: Sage.
- Ellis, C., G. L. Theodori, P. Petrzela, D. Jackson-Smith, and A. E. Luloff. 2016. Unconventional risks: the experience of acute energy development in the Eagle Ford Shale. *Energy Research & Social Science* 20: 91–8.
- Emery, M., and C. Flora. 2006. Spiraling-up: mapping community transformation with community capitals framework. *Community Development* 37 (1): 19–35. doi:10.1080/15575330609490152.
- Energy Infrastructure and Impact Office. N.d. Energy infrastructure and impact office grants. Accessed October 17, 2020. <https://www.land.nd.gov/energy-infrastructure-impact-office-eiio-grants>.
- Enoch, S., and E. Eaton. 2018. A prairie patchwork: reliance on oil industry philanthropy in Saskatchewan boom towns. Canadian Centre for Policy Alternatives, Regina, SK.
- Erickson, J. D., and S. U. O'Hara. 2000. From top-down to participatory planning: conservation lessons from the Adirondack Park, United States. In *Biodiversity and ecological economics: participation, values, and resource management*, ed. L. Tacconi, 147–61. London: Earthscan Publications.
- Fleming, D., T. Komarek, M. Partridge, and T. Measham. 2015. The booming socioeconomic impacts of shale: a review of findings and methods in the empirical literature. Munich Personal RePEc Archive 68487.
- Folke, C. 2006. Resilience: the emergence of a perspective for social-ecological systems analyses. *Global Environmental Change* 16 (3): 253–67.
- Folke, C. 2016. Resilience. *Oxford Research Encyclopedia of Environmental Science*: 1–68. doi:10.1093/acrefore/9780199389414.013.8.
- Freudenburg, W. R. 1992. Addictive economies: extractive industries and vulnerable localities in a changing world economy. *Rural Sociology* 57 (3): 305–32.
- Freudenburg, W. R., and R. Gramling. 1992. Community impacts of technological change: toward a longitudinal perspective. *Social Forces* 70: 937–55.

- Furlong, K. 2019. Geographies of infrastructure 1: economies. *Progress in Human Geography*. <https://doi.org/10.1177%2F0309132519850913>.
- Gaswirth, S. B., K. R. Marra, T. A. Cook, R. R. Charpentier, D. L. Gautier, D. K. Higley, T. R. Klett, M. D. Lewan, P. G. Lillis, C. J. Schenk, et al. 2013. Assessment of undiscovered oil resources in the Bakken and Three Forks Formations, Williston Basin Province, Montana, North Dakota, and South Dakota, 2013. US Geological Survey Fact Sheet 3013, Department of the Interior, Washington, DC.
- Gilbertz, S. J., M. B. Anderson, and J. M. Adkins. 2020. The Bakken blind field: investigating planetary urbanization and opaqueness in the oil and gas fields of eastern Montana. *Annals of the American Association of Geographers*: 1–18.
- Gilmore, J. S. 1976. Boom towns may hinder energy resource development. *Science* 191 (4227): 535–40.
- Gilmour, J. 2015. Low oil prices chill a once-hot oil town in North Dakota. *Christian Science Monitor*, January 24.
- Glaeser, E. L. 2016. If you build it...Myths and realities about America's infrastructure spending. *City Journal*, Summer.
- Golden-Biddle, K., and K. Locke. 1993. Appealing work: an investigation of how ethnographic texts convince. *Organization Science* 4 (4): 595–616.
- Goodman, C., M. E. Hatch, and B. D. McDonald III. 2020. State preemption of local laws: origins and modern trends. *Perspectives on Public Management & Governance*. <https://doi.org/10.1093/ppmgov/gvaa018>.
- Graham, J., J. Irving, X. Tang, S. Sellers, J. Crisp, D. Horwitz, L. Muehlenbachs, A. Krupnick, and D. Carey. 2015. Increased traffic accident rates associated with shale gas drilling in Pennsylvania. *Accident Analysis & Prevention* 74: 203–9.
- Grubert, E. 2018. The Eagle Ford and Bakken shale regions of the United States: a comparative case study. *The Extractive Industries and Society* 5 (4): 570–80.
- Haarstad, H., and T. I. Wanvik. 2017. Carbonscapes and beyond: conceptualizing the instability of oil landscapes. *Progress in Human Geography* 41 (4): 432–50.
- Hageman, J. 2019. Despite pleas for road funding, North Dakota senate rejects gas tax increase. *Bismarck Tribune*, February 4. https://bismarcktribune.com/news/local/govt-and-politics/despite-pleas-for-road-funding-north-dakota-senate-rejects-gas/article_731ec69f-503a-52cf-a51c-1f12246eed71.html.

- Hagen, E. 2020. Whiting Petroleum Corporation reaches agreement in principle with certain of its noteholders to pursue consensual financial restructuring. News Release, Whiting Petroleum Corporation, Denver, CO, April 1. <https://www.sec.gov/Archives/edgar/data/1255474/000119312520093737/d899645dex992.htm>.
- Haggerty, J. H., K. K. Smith, J. Weigle, T. W. Kelsey, K. B. Walsh, R. Coupal, D. Kay, and P. Lachapelle. 2019. Tradeoffs, balancing, and adaptation in the agriculture-oil and gas nexus: insights from farmers and ranchers in the United States. *Energy Research & Social Science* 47: 84–92.
- Haggerty, J. H., K. K. Smith, T. Mastel, J. Lapan, and P. Lachapelle. 2018. Assessing, monitoring, and addressing boomtown impacts in the US: evaluating an existing public health model. *Impact Assessment and Project Appraisal* 36 (1): 115–27.
- Haggerty, J. H., A. C. Kroepsch, K. B. Walsh, K. K. Smith, and D. W. Bowen. 2018. Geographies of impact and the impacts of geography: unconventional oil and gas in the American West. *The Extractive Industries and Society* 5 (4): 619–33.
- Haggerty, J., and K. McBride. 2016. Does local monitoring empower fracking host communities? A case study from the gas fields of Wyoming. *Journal of Rural Studies* 43: 235–47.
- Haggerty, M. N. 2020. *How fiscal policy is failing rural America*. Headwaters Economics, Bozeman, MT.
- Haggerty, M. N. 2012. Benefiting from unconventional oil: state fiscal policy is unprepared for the heightened community impacts of unconventional oil plays. Headwaters Economics, Bozeman, MT. <https://headwaterseconomics.org/energy/oil-gas/unconventional-oil-and-north-dakota-communities/>.
- Haggerty, M. N., and J. H. Haggerty. 2015. Energy development as opportunity and challenge in the rural West. In *The rural West: common regional issues*, ed. D. Danbom, 161–90. Salt Lake City: University of Utah Press.
- Halkias, M. 2020. Oil prices fall to historic lows as West Texas crude futures drop below \$0. *The Dallas Morning News*, April 20. With contributions from C. Ngai, O. Raimonde, and A. Longley of Bloomberg News. <https://www.dallasnews.com/business/energy/2020/04/20/oil-prices-fall-to-historic-lows-as-west-texas-crude-futures-go-negative/>.
- Halseth, G. 2016. Introduction: political economy perspectives on the transformation of resource towns and peripheries. In *Transformation of resource towns and peripheries*, ed. G. Halseth, 1–10. New York: Routledge.

- Halseth, G., and L. Ryser. 2006. Trends in service delivery: examples from rural and small town Canada, 1998 to 2005. *Journal of Rural and Community Development* 1 (2).
- Halseth, G., and L. Ryser. 2017. *Towards a political economy of resource-dependent regions*. New York: Routledge.
- Hamlin, H. S., K. Smye, R. Dommissie, R. Eastwood, C. R. Lemons, and G. McDaid. 2017. Geology and petrophysics of the Bakken unconventional petroleum system. In *Unconventional Resources Technology Conference, Austin, Texas, July 24–26*, 1294–1307. Society of Exploration Geophysicists. <https://doi.org/10.15530/urtec-2017-2670679>.
- Hanson, S., and E. Geary. 2020. North Dakota flared 19% of its natural gas production in 2019. U.S. Energy Information Administration, Washington, DC. <https://www.eia.gov/todayinenergy/detail.php?id=43435>.
- Harrison, J. L., C. A. Montgomery, and J. C. Bliss. 2016. Beyond the monolith: the role of bonding, bridging, and linking social capital in the cycle of adaptive capacity. *Society & Natural Resources* 29 (5): 1–15.
- Harvey, D. 2001. *Spaces of capital: towards a critical geography*. New York: Routledge.
- Harvey, D. 2005. *A brief history of neoliberalism*. Oxford: Oxford University Press.
- Harvey, P., and H. Knox. 2015. *Roads: an anthropology of infrastructure and expertise*. Ithaca, NY: Cornell University Press.
- Hayter, R., and J. Patchell. 2015. Resource geography. *International Encyclopedia of the Social and Behavioral Sciences*. 2nd ed. 20: 568–75.
- Hayter, R., T. J. Barnes, and M. J. Bradshaw. 2003. Relocating resource peripheries to the core of economic geography's theorizing: rationale and agenda. *Area* 35 1: 15–23.
- Hearne, R. R., and F. N. Fernando. 2016. Strategies for community and industry water management in the oil producing region of North Dakota. *Water* 8 (8): 331.
- Helms, L. 2020. Oil industry outlook. Western Dakota Energy Association Annual Meeting, October 16. <https://www.youtube.com/watch?v=NAwSee9N1cE>.
- Hennip, R. D. 1973. History of the crude oil industry in Montana. MBA thesis, University of Montana.
- Herz, C. A. 2013. Petroleum exploration history in North Dakota to 1951. MS thesis, University of North Dakota.

- Hibbard, M., and S. Lurie. 2015. The new natural resource economy: a framework for rural community resilience. In *Bridging the distance: common issues of the rural West*, ed. D. B. Danbom, 192–210. Salt Lake City: University of Utah Press.
- Hitaj, C., A. Boslett, and J. G. Weber. 2014. Shale development and agriculture. *Choices* 29 (4).
- Holling, C. S. 1973. Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics* 4: 1–23.
- Holling, C. S. 1986. The resilience of terrestrial ecosystems: local surprise and global change. In *Sustainable development of the biosphere: interactions between the world economy and the global environment*, ed. W. C. Clark, 292–317. Cambridge, UK: Cambridge University Press.
- Holling, C. S., and S. M. Sundstrom. 2015. Adaptive management: a personal history. In *Adaptive management of social-ecological systems*, ed. C. Allen and A. Garmestani, 11–25. Dordrecht: Springer Netherlands.
- Horn, A. 2019. Gas tax increase draws no opposition in committee, but at the pump. *KFYR TV*, January 22. <https://www.kfyrtv.com/content/news/Gas-tax-increase-draws-no-opposition-in-committee-but-at-the-pump-504728871.html>.
- Horner, R. M., C. B. Harto, R. B. Jackson, E. R. Lowry, A. R. Brandt, T. W. Yeskoo, D. J. Murphy, and C. E. Clark. 2016. Water use and management in the Bakken shale oil play in North Dakota. *Environmental Science & Technology* 50 (6): 3275–82.
- Howe, C., J. Lockrem, H. Appel, E. Hackett, D. Boyer, R. Hall, M. Schneider-Mayerson, A. Pope, A. Gupta, E. Rodwell, et al. 2016. Paradoxical infrastructures: ruins, retrofit, and risk. *Science Technology & Human Values* 41 (3): 547–65.
- Huber, M. 2015. energy and social power: from political ecology to the ecology of politics. In *The Routledge handbook of political ecology*, ed. T. Perreault, G. Bridge, and J. McCarthy, 481–92. New York: Routledge.
- Huber, M. T. 2017. Hidden abodes: industrializing political ecology. *Annals of the American Association of Geographers* 107 (1): 151–66.
- Humphreys, M., J. D. Sachs, J. E. Stiglitz, G. Soros, and M. Humphreys. 2007. *Escaping the resource curse*. New York: Columbia University Press.
- Jackson, J. 2020. Economic outlook: a forecast of the effect of COVID-19 on North Dakota. Center for the Study of Public Choice and Private Enterprise, North Dakota State University, Fargo. https://www.ndsu.edu/fileadmin/centers/pcpe/Economic_Outlook/EO_Covid19.pdf.

- Jacquet, J. 2014. Review of risks to communities from shale energy development. *Environmental Science & Technology* 48 (15): 8321–33.
- Jacquet, J. B., and Kay, D. L. 2014. The unconventional boomtown: updating the impact model to fit new spatial and temporal scales. *Journal of Rural and Community Development* 9 (1): 1–23.
- Jacquet, J. B., K. Witt, W. Rifkin, and J. H. Haggerty. 2018. A complex adaptive system or just a tangled mess? Property rights and shale gas governance in Australia and the US. In *Governing shale gas*, ed. J. Whitton, M. Cotton, I. M. Charnley-Parry, and K. Brasier, 55–68. New York: Routledge.
- Jacquet, J., and R. C. Stedman. 2011. Natural gas landowner coalitions in New York State: emerging benefits of collective natural resource management. *Journal of Rural Social Sciences* 26 (1): 62.
- Jacquet, J. B. 2015. The rise of “private participation” in the planning of energy projects in the rural United States. *Society & Natural Resources* 28 (3): 231–45.
- Jacquet, J. B., A. N. Junod, D. Bugden, G. Wildermuth, J. T. Fergen, K. Jalbert, B. Rahmb, P. Hagleya, K. J. Brasier, K. Schafft, et al. 2018b. A decade of Marcellus Shale: impacts to people, policy, and culture from 2008 to 2018 in the Greater Mid-Atlantic region of the United States. *The Extractive Industries and Society* 5 (4): 596–609.
- Jacquet, J. 2009. Energy boomtowns and natural gas: implications for Marcellus shale local governments and rural communities. NERCRD Rural Development 43, Northeast Regional Center for Rural Development, University Park, PA. <http://energy.wilkes.edu/PDFFiles/Issues/Energy%20Boomtowns%20and%20Natural%20Gas.pdf>.
- Jean, R. 2018. Royalty owners questioning deductions. *Williston Herald*, October 9. https://www.willistonherald.com/news/royalty-owners-questioning-deductions/article_163985d2-cb43-11e8-990b-f73131ec6d64.html.
- Job Service North Dakota. 2019. Quarterly census of employment and wages (QCEW) for mining, quarrying, and oil and gas extraction. Job Service North Dakota, Bismarck, ND. <https://www.ndworkforceintelligence.com>.
- Junkert, K., and D. Goehring. 2016. Pipeline restoration and reclamation oversight pilot program. North Dakota Department of Agriculture.
- Junod, A. N., J. B. Jacquet, F. Fernando, and L. Flage. 2018. Life in the goldilocks zone: perceptions of place disruption on the periphery of the Bakken Shale. *Society & Natural Resources* 31 (2): 200–17.

- Kaika, M. 2005. *City of flows: modernity, nature, and the city*. New York: Routledge.
- Kelsey, T., M. Partridge, and N. White. 2014. Unconventional gas and oil development in the United States: economic experience and policy issues. *Applied Economics Perspectives and Policy* 38 (2): 191–214.
- Keough, S. B. 2015. Planning for growth in a natural resource boomtown: challenges for urban planners in Fort McMurray, Alberta. *Urban Geography* 36 (8): 1169–96.
- Kim, J., and T. G. Johnson. 2020. The shale oil boom and comprehensive wealth of the Bakken region of North Dakota. *Community Development*: 1–21.
- Kinne, B. 2018. Regulating unconventional shale gas development in the United States: diverging priorities, overlapping jurisdictions, and asymmetrical data access. In *Governing shale gas*, ed. J. Whitton, M. Cotton, I. M. Charnley-Parry, and K. Brasier, 23–50. New York: Routledge.
- Klassen, J. A., and A. M. Feldpausch-Parker. 2011. Oiling the gears of public participation: the value of organizations in establishing Trinity of Voice for communities impacted by the oil and gas industry. *Local Environment* 16 (9): 903–15.
- Kohrs, E. V. 1974. Social consequences of boom growth in Wyoming. Paper presented at the Rocky Mountain American Association of the Advancement of Science Meeting, Laramie, WY, April 24–26.
<http://www.sublettewyo.com/Archive/ViewFile/Item/97>.
- Konschnik, K. E., and M. K. Boling. 2014. Shale gas development: a smart regulation framework. *Environmental Science & Technology* 48 (15): 8404–16.
- Kraenzel, C. F. 1955. *The great plains in transition*. Norman: University of Oklahoma Press.
- Kroepsch, A. C., P. T. Maniloff, J. L. Adgate, L. M. McKenzie, and K. L. Dickinson. 2019. Environmental justice in unconventional oil and natural gas drilling and production: a critical review and research agenda. *Environmental Science & Technology* 53 (12): 6601–15.
- Krupnick, A. J., I. Echarte, and L. Muehlenbachs. 2017. Local government impacts of unconventional oil and gas. The Community Impacts of Shale Gas and Oil Development, Resources for the Future, Washington, DC.
https://media.rff.org/archive/files/document/file/RFF-Rpt-ShaleReviews_LocalGovt_0.pdf.

- Kulig, J., D. S. Edge, I. Townshend, N. Lightfoot, and W. Reimer. 2013. Community resiliency: emerging theoretical insights. *Journal of Community Psychology* 41 (6): 758–75. doi:10.1002/jcop.21569.
- Kurz, B. A., D. J. Stepan, K. A. Glazewski, B. G. Stevens, T. E. Doll, J. T. Kovacevich, and C. A. Wocken. 2016. A review of Bakken water management practices and potential outlook. University of North Dakota Energy and Environmental Research Center, Grand Forks, ND.
- Kusnetz, N. 2012. The Bakken oil play spurs a booming business – in water. *High Country News*, August 6. <https://www.hcn.org/issues/44.13/the-bakken-oil-play-spurs-a-booming-business-in-water>.
- Lee, M. 2020a. “Brutal”: 100k jobs lost as rig count hits all-time low. *E&E News*, June 15. <https://www.eenews.net/energywire/stories/1063389519/>.
- Lee, M. 2020b. A five-alarm fire for North Dakota’s oil and gas industry. *E&E News*, July 20. <https://www.eenews.net/energywire/2020/07/20/stories/1063593773>.
- Levi-Faur, D. 2005. The global diffusion of regulatory capitalism. *The Annals of the American Academy of Political and Social Science* 598 (1): 12–32.
- Lin, Z., T. Lin, S. H. Lim, M. H. Hove, and W. M. Schuh. 2018. Impacts of Bakken shale oil development on regional water uses and supply. *Journal of the American Water Resources Association* 54 (1): 225–39.
- Lindlof, T. R. 1995. *Qualitative communication research methods*. Vol. 3. Thousand Oaks, CA: Sage.
- Lindlof, T. R., and B. C. Taylor. 2011. *Qualitative communication research methods*. Thousand Oaks, CA: Sage.
- LoadPass Permits. 2020. About the LoadPass permit program. Accessed October 17, 2020. <https://permits.loadpasspermits.com/About/Program>.
- Luke, H., M. Brueckner, and N. Emmanouil. 2018. Unconventional gas development in Australia: a critical review of its social license. *The Extractive Industries and Society* 5 (4): 648–62.
- Maciag, M. 2012. North Dakota leads in hyper-local government. *Governing*, September 13. <https://www.governing.com/news/state/gov-north-dakota-most-governments-per-capita.html>.
- Magis, K. 2010. Community resilience: an indicator of social sustainability. *Society and Natural Resources* 23: 401–16. doi:10.1080/08941920903305674.

- Malin, S. A., T. Opsal, T. O'Connor Shelley, and P. M. Hall. 2019. The right to resist or a case of injustice? Meta-power in the oil and gas fields. *Social Forces* 97 (4): 1811–38.
- Malin, S. A., and K. T. DeMaster. 2016. A devil's bargain: rural environmental injustices and hydraulic fracturing on Pennsylvania's farms. *Journal of Rural Studies* 47: 278–90.
- Manz, L. 2013. The public land survey system (PLSS) part 1. *North Dakota Geological Survey Geo News*.
<https://www.dmr.nd.gov/ndgs/documents/newsletter/2013Summer/PLSS-Part1.pdf>.
- Markey, S., G. Halseth, L. Ryser, N. Argent, and J. Boron. 2019. Bending the arc of the staples trap: negotiating rural resource revenues in an age of policy incoherence. *Journal of Rural Studies* 67: 25–36.
- Martin, R., and P. Sunley. 2014. On the notion of regional economic resilience: conceptualisation and explanation. *Journal of Economic Geography* 15 (1): 1–42. doi:10.1093/jeg/lbu015.
- Mastel, T., K. K. Smith, J. H. Haggerty, and K. B. Walsh. 2016. Communities in Action program evaluation: report to Richland County Department of Public Health. Resources and Communities Research Group, Department of Earth Sciences, Montana State University, Bozeman, MT.
- Maugeri, L. 2013. The shale oil boom: a US phenomenon. Harvard Kennedy School, Belfer Center for Science and International Affairs, Cambridge, MA.
- Mayer, A. 2017. Quality of life and unconventional oil and gas development: towards a comprehensive impact model for host communities. *The Extractive Industries and Society* 4 (4): 923–30.
- Mayer, A., and S. Malin. 2018. Keep it local? Preferences for federal, state, or local unconventional oil and gas regulations. *Energy Research & Social Science* 44: 336–45.
- Mayer, A., S. K. Olson-Hazboun, and S. Malin. 2018. Fracking fortunes: economic well-being and oil and gas development along the urban-rural continuum. *Rural Sociology* 83 (3): 532–67.
- McCarthy, J. 2002. First world political ecology: lessons from the wise use movement. *Environment and Planning A* 34 (7): 1281–1302.

- McNally, M. S., and A. R. Brandt. 2015. The productivity and potential future recovery of the Bakken formation of North Dakota. *Journal of Unconventional Oil and Gas Resources* 11: 11–8.
- McNally, R. 2017. *Crude volatility: the history and the future of boom-bust oil prices*. New York: Columbia University Press.
- Measham, T. G., D. A. Fleming, and H. Schandl. 2016. A conceptual model of the socioeconomic impacts of unconventional fossil fuel extraction. *Global Environmental Change* 36: 101–10.
- Meehan, K. M. 2014. Tool-power: water infrastructure as wellsprings of state power. *Geoforum* 57: 215–24.
- Mihalyi, D., A. Adam, and J. Hwang. 2020. Resource-backed loans: pitfalls and potential. Natural Resource Governance Institute, New York, NY.
- Moffat, K., and A. Zhang. 2014. The paths to social license to operate: an integrative model explaining community acceptance of mining. *Resources Policy* 39: 61–70.
- Monstadt, J. 2009. Conceptualizing the political ecology of urban infrastructures: insights from technology and urban studies. *Environment and Planning A* 41 (8): 1924–42.
- Morrison, T. H. 2016. The meta-governance of regions and the need for a political geography of planning. *International Planning Studies* 21 (3): 298–304.
- Murphy, K. 2017. Queensland gas industry welcomes moves to establish land access ombudsman. Australian Petroleum Production & Exploration Association press release, May 24. https://www.appea.com.au/media_release/queensland-gas-industry-welcomes-moves-to-establish-land-access-ombudsman.
- Murphy, T., C. Brannstrom, M. Fry, and M. Ewers. 2018. Economic-development stakeholder perspectives on boomtown dynamics in the Eagle Ford Shale, Texas. *Geographical Review* 108 (1): 24–44.
- Naismith Engineering, Inc. 2015. DeWitt County road damage cost allocation study. Corpus Christi, TX. [http://tools.cira.state.tx.us/users/0041/DeWitt percent20County percent20Roadpercent20Damage percent20Cost percent20Allocation percent20Study.pdf](http://tools.cira.state.tx.us/users/0041/DeWitt%20percent20County%20percent20Roadpercent20Damage%20percent20Cost%20percent20Allocation%20percent20Study.pdf).
- NCPPP (National Council for Public-Private Partnerships). N.d. Seven keys to success. <https://www.ncppp.org/ppp-basics/7-keys/>.
- NDDOT (North Dakota Department of Transportation). 2014. North Dakota Department of Transportation: roads of progress.

- NDDOT (North Dakota Department of Transportation). 2016. State and local officials celebrate completion of Killdeer Truck Bypass project. NDDOT press release, September 28.
<https://www.dot.nd.gov/dotnet/news/docs/2016releases/Killdeer%20press%20release.pdf>
- NDDOT (North Dakota Department of Transportation). 2017. NDDOT Williston District: project updates. Paper presented at the 2017 Construction Conference.
<https://www.dot.nd.gov/conferences/construction/presentations/2017/Bakken%20Update.pdf>.
- NDDOT (North Dakota Department of Transportation). 2019a. Statewide transportation improvement program: 2020 – 2023 final document.
<https://www.dot.nd.gov/manuals/programming/STIP/Final-STIP.pdf>.
- NDDOT (North Dakota Department of Transportation). 2019b. North Dakota transportation handbook 2019.
<http://library.nd.gov/statedocs/Transportation/TransportationHandbook/2019.pdf>.
- Nelson, S. H. 2014. Resilience and the neoliberal counter-revolution: from ecologies of control to production of the common. *Resilience 2*: 1–17.
- Newell, R. G., and D. Raimi. 2015. Oil and gas revenue allocations to local governments in eight states. Working Paper 21615, National Bureau of Economic Research, Cambridge, MA.
- Newell, R. G., and D. Raimi. 2018. The fiscal impacts of increased US oil and gas development on local governments. *Energy Policy* 117: 14–24.
- Norris, F., S. Stevens, B. Pfefferbaum, K. Wyche, and R. Pfefferbaum. 2008. Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology* 41 (1): 127–50.
 doi:10.1007/s10464-007-9156-6.
- North Dakota Job Service. 2020. North Dakota monthly unemployment initial claims. Labor Market Information. Accessed October 18, 2020.
<https://www.ndlmi.com/gsipub/index.asp?docid=687>.
- North Dakota Office of State Treasurer. 2019. How is oil and gas tax revenue distributed? Accessed October 17, 2020. <https://www.treasurer.nd.gov/how-oil-and-gas-tax-revenue-distributed>.
- North Dakota Office of State Treasurer. N.d. North Dakota legacy fund. Accessed October 17, 2020. <https://www.treasurer.nd.gov/north-dakota-legacy-fund-0>.

- North Dakota Oil and Gas Division. 2020. Annual oil and gas production: historical annual oil production totals. Accessed October 22, 2020. <https://www.dmr.nd.gov/oilgas/stats/statisticsvw.asp>.
- North Dakota Oil and Gas Division. N.d. Monthly oil production totals by county. Accessed October 17, 2020. <https://www.dmr.nd.gov/oilgas/stats/countymot.pdf>.
- North Dakota Retirement and Investment Office. 2020. Legacy fund. Accessed October 22, 2020. <https://www.rio.nd.gov/legacy-fund>.
- North Dakota State Water Commission. 2015. North Dakota 2015 state water management plan. Accessed October 22, 2020. <http://www.swc.nd.gov>.
- North Dakota State Water Commission. 2017. Water development report: an update to the 2015 state water plan. Accessed October 22, 2020. http://www.swc.state.nd.us/info_edu/state_water_plan/archives/pdfs/2017_2019_Water_Development_Report.pdf.
- North Dakota. 2020. Local government. Accessed October 17, 2020. <https://www.nd.gov/government/local-government>.
- North Dakota. N.d. Motor fuel history. Accessed October 17, 2020. <https://www.nd.gov/tax/motorfuelhistory/>.
- O'Sullivan, M. L. 2017. *Windfall: how the new energy abundance upends global politics and strengthens America's power*. New York: Simon and Schuster.
- Oates, W. E. 1972. *Fiscal federalism*. New York: Harcourt Brace Jovanovich.
- Olien, R. M., and D. D. Olien. 1982. *Oil booms: social change in five Texas towns*. Lincoln: University of Nebraska Press.
- Ova, K., and J. Hough. 1999. Guidelines for consolidating township roads: a case study showing benefit/cost analysis for closing township roads in North Dakota. North Dakota State University, Upper Great Plains Transportation Institute, Fargo, ND. <https://www.ugpti.org/resources/reports/details.php?id=347>.
- Parrott, L., C. Chion, R. Gonzalès, and G. Latombe. 2012. Agents, individuals, and networks: modeling methods to inform natural resource management in regional landscapes. *Ecology and Society* 17 (3). doi:10.5751/ES-04936-170332.
- Peck, J., and A. Tickell. 2002. Neoliberalizing space. *Antipode* 34 (3): 380–404.
- Peterson, G. 2000. Political ecology and ecological resilience: an integration of human and ecological dynamics. *Ecological Economics* 35 (3): 323–36. doi:10.1016/S0921-8009(00)00217-2.

- Petroski, H. 2016. *The road taken: the history and future of America's infrastructure*. New York: Bloomsbury.
- Pike, A., A. Rodriguez-Pose, and J. Tomaney. 2006. *Local and regional development*. New York: Routledge.
- Pitman, J. K., L. C. Price, and J. A. LeFever. 1999. Diagenesis and fracture development in the Bakken Formation, Williston Basin. Implications for reservoir quality in the middle member: United States Geological Survey Professional Paper 1653, U.S. Geological Survey, Denver, CO.
- Rabe, B. G. 2014. Shale play politics: the intergovernmental odyssey of American shale governance. *Environmental Science & Technology* 48 (15): 8369–75.
- Raimi, D. 2017. *The fracking debate: the risks, benefits, and uncertainties of the shale revolution*. New York: Columbia University Press.
- Reed, S., and C. Krauss. 2020. Too much oil: how a barrel came to be worth less than nothing. *The New York Times*, April 20. Updated April 27, 2020. <https://www.nytimes.com/2020/04/20/business/oil-prices.html>.
- Rifkin, W., K. Witt, J. Everingham, and V. Uhlmann. 2015. Benefits and burdens for rural towns from Queensland's onshore gas development. In *SPE Asia Pacific Unconventional Resources Conference and Exhibition*. Society of Petroleum Engineers.
- Robbins, P. 2012a. *Lawn people: how grasses, weeds, and chemicals make us who we are*. Philadelphia: Temple University Press.
- Robbins, P. 2012b. *Political ecology*. 2nd ed. Vol. 16. West Sussex, UK: John Wiley & Sons.
- Robertson, M. 2015. Environmental governance: political ecology and the state. In *The Routledge handbook of political ecology*, ed. T. Perreault, G. Bridge, and J. McCarthy, 457–66. New York: Routledge.
- Robinson, L. W., and F. Berkes. 2011. Multi-level participation for building adaptive capacity: formal agency-community interactions in northern Kenya. *Global Environmental Change* 21: 1185–94.
- Ross, M. L. 1999. The political economy of the resource curse. *World Politics* 51 (2): 297–322.
- Russell, E. 2019. The first new US airport since 2011 is in North Dakota's oil country. The Points Guy. Accessed October 25, 2020. <https://thepointsguy.com/news/the-first-new-us-airport-since-2010-is-in-north-dakotas-oil-country/>.

- Ryder, S. S. 2017. Unconventional regulation for unconventional energy in Northern Colorado? Municipalities as strategic actors and innovators in the United States. *Energy Research & Social Science* (26): 23–33.
- Ryser, L., G. Halseth, S. Markey, C. Gunton, and N. Argent. 2019. Path dependency or investing in place: understanding the changing conditions for rural resource regions. *The Extractive Industries and Society* 6 (1): 29–40.
- Sachs, J., and A. Warner. 1995. Natural resource abundance and economic growth. NBER Working Paper No. 5398, National Bureau of Economic Research, Cambridge, MA.
- Schafft, K. A., L. L. Glenna, B. Green, and Y. Borlu. 2014. Local impacts of unconventional gas development within Pennsylvania's Marcellus shale region: gauging boomtown development through the perspectives of educational administrators. *Society & Natural Resources* 27 (4): 389–404.
- Schafft, K. A., K. Brasier, and A. Hesse. 2018. Reconceptualizing rapid energy resource development and its impacts: thinking regionally, spatially and intersectionally. *Journal of Rural Studies* 68: 296–305.
- Scheyder, E. 2013. Insight: the fight for North Dakota's fracking-water market. *Reuters*, May 20. <https://in.reuters.com/article/us-water-bakken-insight/insight-the-fight-for-north-dakotas-fracking-water-market-idUSBRE94J02120130520>.
- Scott, R. P. 2016. Independent review of the Gasfields Commission Queensland and associated matters. Department of State Development, Brisbane, Queensland, Australia. <https://cabinet.qld.gov.au/documents/2016/Oct/RevGasComm/Attachments/Report.PDF>.
- Silva, T. J., and J. A. Crowe. 2015. The hope-reality gap: rural community officials' perceptions of unconventional shale development as a means to increase local population and revitalize resource extraction. *Community Development* 46 (4): 312–28.
- Small, M. J., P. C. Stern, E. Bomberg, S. M. Christopherson, B. D. Goldstein, A. L. Israel, R. B. Jackson, A. Krupnick, M. S. Mauter, J. Nash, et al. 2014. Risks and risk governance in unconventional shale gas development. *Environmental Science & Technology* 48 (15): 8289–97.
- Smith, A., and A. Stirling. 2010. The politics of social-ecological resilience and sustainable socio-technical transitions. *Ecology and Society* 15 (1).

- Smith, K. K., and Haggerty, J. H. 2018. Devolved governance & alternative dispute resolution programs: an example from the Bakken. In *Governing shale gas*, ed. K. Brasier, M. Cotton, and J. Whitton, 184–97. London: Routledge.
- Smith, K. K., and J. H. Haggerty. 2020. Exploitable ambiguities and the unruliness of natural resource dependence: public infrastructure in North Dakota’s Bakken Shale Formation. *Journal of Rural Studies*.
<https://doi.org/10.1016/j.jrurstud.2020.05.006>.
- Smith, K. K., J. H. Haggerty, D. L. Kay, and R. Coupal. 2019. Using shared services to mitigate boomtown impacts in the Bakken Shale Play: resourcefulness or over-adaptation? *Journal of Rural and Community Development* 14 (2): 66–86.
- Smith, M. D., R. S. Krannich, and L. M. Hunter. 2001. Growth, decline, stability, and disruption: a longitudinal analysis of social well-being in four western rural communities. *Rural Sociology* 66 (3): 425–50.
- Smith, N. 2013. Water project compromise “manageable.” *Bismarck Tribune*, May 17.
https://bismarcktribune.com/bakken/water-project-compromise-manageable/article_c809d160-bf30-11e2-b944-001a4bcf887a.html.
- Solomon, B. D., M. J. Pasqualetti, and D. A. Luchsinger. 2004. Energy geography. In *Geography in America at the dawn of the 21st century*, ed. G. Gaile and C. Willmott, 302–13. Oxford: Oxford University Press.
- St. Martin, K. 2001. Making space for community resource management in fisheries. *Annals of the Association of American Geographers* 91 (1): 122–42.
- Stantec Consulting Services, Inc. 2018. Industrial water supply infrastructure: financial analysis of the Western Area Water Supply Authority. Stantec, Bismarck, ND.
https://www.legis.nd.gov/files/committees/65-2017/19_5129_03000appendix1.pdf.
- Stedman, R. C., J. R. Parkins, and T. M. Beckley. 2004. Resource dependence and community well-being in rural Canada. *Rural Sociology* 69 (2): 213–34.
- Svihovec, L. 2018. 4-County oil impact analysis: Dunn, McKenzie, Mountrail, and Williams Counties. Western Dakota Energy Association and AE2S Nexus. Energy & Environmental Research Center, Grand Forks, ND, June 24.
- Theodori, G. L. 2018. Shale energy development in the Southern United States: a review of perceived and objective social impacts. *The Extractive Industries and Society* 5 (4).

- Tolbert, C. M. 2006. Sustainable community in oil and gas country: final report. OCS Study MMS 2006-011. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA.
- Tolliver, D. 2014. Transportation systems for oil and gas development: case study of the Bakken Shale. Presented at International Transportation and Economic Development (I-TED) Conference, Dallas, Texas, April 9–11.
<https://static.tti.tamu.edu/conferences/ited2014/presentations/A3-tolliver.pdf>.
- Tolliver, D. and A. Dybing. 2010. An assessment of county and local road infrastructure needs in North Dakota. Report for the North Dakota Legislative Assembly. Upper Great Plains Transportation Institute, North Dakota State University, Fargo, ND.
- Tolliver, D., B. Wentz, A. Dybing, P. Lu, A. Bratlien, T. Horner, E. Lee, Y. Kazemi, N. Dharmadhikari, C. DeHaan, L. Holt, C. Ifepe, and S. Shakya. 2012. Additional road investments needed to support oil and gas production and distribution in North Dakota. Report for the North Dakota Legislative Assembly. Upper Great Plains Transportation Institute, North Dakota State University, Fargo, ND.
- Tonts, M., K. Martinus, and P. Plummer. 2013. Regional development, redistribution and the extraction of mineral resources: the Western Australian Goldfields as a resource bank. *Applied Geography* 45: 365–74.
- Tonts, M., P. Plummer, and M. Lawrie. 2012. Socio-economic wellbeing in Australian mining towns: a comparative analysis. *Journal of Rural Studies* 28 (3): 288–301.
- Trainor, A. M., R. I. McDonald, and J. Fargione. 2016. Energy sprawl is the largest driver of land use change in United States. *PloS one* 11 (9).
- Turner, M. D. 2014. Political ecology I: an alliance with resilience? *Progress in Human Geography* 38 (4): 616–23.
- UGPTI (Upper Great Plains Transportation Institute) and NDDOT (North Dakota Department of Transportation). 2018. North Dakota Symposium on Transportation Funding, Fargo, ND, June 5.
https://www.dot.nd.gov/public/docs/fundingsymposium/UGPTI%20Report%20ND%20Symposium%20on%20Transportation%20Funding_June0518FINAL.pdf.
- UGPTI (Upper Great Plains Transportation Institute). 2013. North Dakota truck size and weight education program: a cooperative project between North Dakota Department of Transportation, North Dakota Highway Patrol, North Dakota Local Technical Assistance Program and Upper Great Plains Transportation Institute, Fargo, ND.
- U.S. Census Bureau. 2010. American Community Survey 5-Year Data Profiles.
<http://data.census.gov>.

- U.S. Census Bureau. 2018. American Community Survey 5-Year Data Profiles. <http://data.census.gov>.
- U.S. Department of Commerce. 2019. Regional economic accounts. Bureau of Economic Analysis, Washington, DC, as reported by Headwaters Economics' Economic Profile System (headwaterseconomics.org/eps).
- U.S. Geological Survey. 2018. Gap Analysis Program. Protected areas database of the United States (PADUS) version 2.0, as reported in Headwaters Economics' Economic Profile System (headwaterseconomics.org/eps).
- Urban Institute. 2020. Highway and road expenditures. State and local finance initiative. Accessed October 2017, 2020. <https://www.urban.org/policy-centers/cross-center-initiatives/state-and-local-finance-initiative/state-and-local-backgrounders/highway-and-road-expenditures>.
- US Energy Information Administration. 2020a. Drilling productivity report, October 13. <https://www.eia.gov/petroleum/drilling/>.
- US Energy Information Administration. 2020b. Frequently asked questions: how much shale (tight) oil produced in the United States? <https://www.eia.gov/tools/faqs/faq.php?id=847&t=6>.
- Wagener, D. V. 2018. Oil and natural gas resources and technology. Annual energy outlook, 2018. U.S. Energy Information Administration, Washington, DC. <https://www.eia.gov/outlooks/aeo/grt.php>.
- Walker, B., and D. Salt. 2006. *Resilience thinking*. Washington, DC: Island Press.
- Walker, B., and D. Salt. 2012. *Resilience practice: building capacity to absorb disturbance and maintain function*. Washington, DC: Island Press.
- Walker, P. A. 2003. Reconsidering "regional" political ecologies: toward a political ecology of the rural American West. *Progress in Human Geography* 27 (1): 7–24.
- Walker, R. A. 2001. California's golden road to riches: natural resources and regional capitalism 1848–1940. *Annals of the Association of American Geographers* 91 (1): 167–99.
- Wallerstein, I. 2004. *World-systems analysis*. Durham, NC: Duke University Press.
- Walsh-Dilley, M., W. Wolford, and J. McCarthy. 2016. Rights for resilience: food sovereignty, power, and resilience in development practice. *Ecology and Society* 21 (1): 11.

- Walsh, K. B., and J. H. Haggerty. 2019. I'd do it again in a heartbeat: coalbed methane development and satisfied surface owners in Sheridan County, Wyoming. *The Extractive Industries and Society* 6 (1): 85–93.
- Walsh, K. B., and J. H. Haggerty. 2020. Social license to operate during Wyoming's coalbed methane boom: implications of private participation. *Energy Policy* 138: 111217.
- Wang, Z., and A. Krupnick. 2013. US shale gas development: what led to the boom. *Resources for the Future* 13 (4): 1–14.
- Warner, B., and J. Shapiro. 2013. Fractured, fragmented federalism: a study in fracking regulatory policy. *Publius: The Journal of Federalism* 43 (3): 474–96.
- Warner, M. E. 2010. The future of local government: twenty-first-century challenges. *Public Administration Review* 70.
- Warner, M. 2017. Lessons learned from ICMA's alternative service delivery survey. Paper presented at the 2017 ICMA Conference, San Antonio, TX, October 23.
- Watts, M. 2004. Resource curse? Governmentality, oil and power in the Niger delta, Nigeria. *Geopolitics* [Special issue] 9/1.
- Watts, M. J. 1983. *Silent violence: food, famine, and peasantry in northern Nigeria*. Geographies of Justice and Social Transformation 15. Berkeley, CA: University of California Press.
- WDEA (Western Dakota Energy Association). 2019. 2019 Annual Meeting Presentations, Fargo, ND, October 30–31. <https://ndenergy.org/News/2019-Annual-Meeting-Presentations>.
- WDEA (Western Dakota Energy Association). 2020. About LoadPass permits. Accessed October 17, 2020. <https://www.loadpasspermits.com/About>.
- Western Area Water Supply Project (WAWS). 2018. 2019-2021 legislative request: \$50M. Accessed May 4, 2019. <http://wawsp.com/news-events/buzz-3rd-quarter-2018/2019-2021-legislative-request-50m/>.
- Western Area Water Supply Project (WAWS). 2019. 2019 legislative progress report. Accessed May 4, 2019. <http://wawsp.com/news-events/1st-quarter-buzz/2019-legislative-progress-report/>.
- Whitton, J., K. J. Brasier, I. Charnley-Parry, and M. Cotton. 2017. Shale gas governance in the United Kingdom and the United States: opportunities for public participation and the implications for social justice. *Energy Research & Social Science* 26: 11–22.

- Wilkinson, C. 2011. Social-ecological resilience: insights and issues for planning theory. *Planning Theory* 11 (2): 148–69. doi:10.1177/1473095211426274.
- Wilkinson, T. 1982. Environmental programme for offshore oil operations. *Chemistry and Industry* 4: 115–23.
- Wilson, C. E., T. H. Morrison, J-A. Everingham, and J. McCarthy. 2017. Steering social outcomes in America's energy heartland: state and private meta-governance in the Marcellus shale, Pennsylvania. *American Review of Public Administration* 47 (8): 929–44.
- Wilson, G. 2012. *Community resilience and environmental transitions*. New York: Routledge.
- Witt, K., J. Whitton, and W. Rifkin. 2018. Is the gas industry a good neighbour? A comparison of UK and Australia experiences in terms of procedural fairness and distributive justice. *The Extractive Industries and Society* 5 (4): 547–56.
- Woods, M. 2005. *Rural geography: processes, responses and experiences in rural restructuring*. London: Sage Publications.
- Woods, M., and M. Goodwin. 2003. Applying the rural: governance and policy in rural areas. *Country Visions*: 245–62.
- Zimmer, K. S. 2011. New geographies of energy: introduction to the special issue. *Annals of the Association of American Geographers* 101 (4): 705–11.
- Zirogiannis, N., J. Alcorn, J. Rupp, S. Carley, and J. D. Graham. 2016. State regulation of unconventional gas development in the US: an empirical evaluation. *Energy Research & Social Science* 11: 142–54.

APPENDICES

APPENDIX A

CAPITAL IMPROVEMENT AND INFRASTRUCTURE PROJECTS

BUILT IN THE BAKKEN SINCE THE UOG BOOM BEGAN

Appendix A provides a selection of infrastructure projects that state and local governments invested in as a result of UOG development. This database includes projects within the boundaries of western North Dakota's top oil-producing counties: Dunn County, McKenzie County, Mountrail County, and Williams County. While the database is not comprehensive, it gives the reader a sense of the scale, magnitude, and funding strategies of infrastructure investments in this region due to UOG development.

	Jurisdiction	Project	Project Type	Est. Cost	Funding Details
Regional	NDDOT	SURGE Funding for Road Improvements	Road	\$1.1 billion	2015 Appropriations, Senate Bill 2103. Funds distributed to counties, cities and the state highway department
	Western Area Water Supply Authority	Western Area Water Supply	Water	\$460 million	Loans backed by state and industrial water sales; Later years included state grants
County	Dunn County	Dunn County Courthouse Addition	Building	\$12.3 million	Federal mineral royalties; Shared space between Dunn County Social Services, North Dakota State University Dunn County extension office, Dunn County Jobs Development Authority and the state's attorney
	Dunn County	Dunn County Municipal Airport - Weydahl Field	Airport	\$5.3 million	\$4.2 million grant from Board of University and School Lands; \$1 million+ funded by Dunn County Commission; Previously owned by city of Killdeer. County took over in 2012 and runs it through Dunn County Airport Authority
	McKenzie County	McKenzie County Healthcare Expansion	Healthcare	\$76.3 million	\$39.2 million from USDA Rural development; \$12.5 million loan from Bank of North Dakota; Community sales tax dollars will provide ~\$700,00/yr for debt payments. Private fundraising (including \$1 million from ONEOK). McKenzie County Commission committed \$1 million
	Mountrail County	Mountrail County Health Center	Healthcare		
	Mountrail County	Mountrail County Justice Center	Law		
	Williams County	Williams County Highway Department	Road	\$22 million	\$12.2 million loan from Bank of North Dakota (back by oil and gas production tax revenues)

	Williams County	Emergency Operations Center (in County Highway Department building)	Emergency		\$1.5 million appropriation from county. 1% safety sales tax used to secure additional funds
	Williams County	Williams County Building Improvements	Building	\$50 million	
Joint Agreement	Watford City / McKenzie County	Combined McKenzie County Law Enforcement Center	Law	\$57 million	Low interest loan from Bank of North Dakota; County and city operate through joint powers agreement
	Watford City / McKenzie County	Wolf Run Village	Housing	\$6 million	\$1.5 million North Dakota Housing Incentive Fund; \$500,000+ ND Law Enforcement Pilot Program; Daycare included extensive private donations (\$1.2 million) and \$125,000 ND Energy Impact Grants. County, city, and school district formed a 501(c)3 to build and run 42 unit affordable housing complex
City	Alexander	Alexander Water System Upgrades	Water	\$1 million	Energy Impact Grant, Board of University and School Lands
	Arnegard	Arnegard Wastewater System Improvements	Wastewater	\$1 million	Energy Impact Grant, Board of University and School Lands
	Killdeer	Killdeer Aquatics & Wellness Center	Recreation	\$7 million	Funded through loans and bonds, as well as sales tax (1% of city's 2% sales tax goes towards maintenance and operations costs)
	Parshall	Parshall Public School Recreation Complex	Recreation	\$10 million	Tribal council of the MHA Nation fully funded the project
	Stanley	Stanley City Hall	Building	\$3 million	
	Stanley	Stanley Recreational Complex	Recreation	\$2 million	The park board bought land in 2016 for a future facility after the city acquired former fields to accommodate housing growth. Additional funding included private donations, grants, and an allocation from the city's sales tax

Tioga	Community Center	Recreation	\$5 million	Full funding plan still not known. Tioga city commission approved spending \$120,000 to add outdoor ice rink.
Watford City	Watford City High School	Education	\$53 million	\$27 million bond. School district financed the rest with \$10 million and \$15 million loans from Bank of North Dakota. Included collaboration & resource sharing with Rough Rider Center
Watford City	Rough Rider Center	Recreation	\$92 million	Land was donated. Built in coordination with new high school. Projects were jointly funded with the school district coming up with \$54 million in loans and grants, and the city government borrowing \$94 million. Of the \$94 million, \$52 million comes from oil and gas revenues and the rest comes from a \$40 million bond to be paid over 20 years using 1.5-cent city sales tax (Roughrider Fund distribution); Bank of North Dakota infrastructure-lending program
Watford City	Watford City Elementary School	Education	\$35 million	Bond
Watford City	Watford City Municipal Airport upgrades (2014)	Airport	\$3.5 million	Federal Aviation Administration contributed \$327,000 for apron project; \$2.04 million (2014 grant from Board of University and School Lands) to fund new airport terminal, apron, and parking lot expansions; Rough Rider (a local community fund) committee granted \$700,000 grant for construction
Watford City	Watford City Municipal Airport upgrades (2019)	Airport	\$26.4 million	
Williston	Williston State College Investments	Education	\$31 million	Includes: \$5 million career and tech building (2011), \$9.8 million new residence hall (2011), \$10.3 million Stevens Hall Renovation (2015), \$2.2 million TrainND campus expansion (2015), \$3.5 million science center (2012), \$300,000 library remodel (2012), \$85,000 Sitting bull public art project (2011), improvements to campus drive, Stevens Hall renovation (completed 2016); Williston State

				College Foundation used funds from their mineral royalties and assisted with fundraising.
Williston	Williston Area Recreation Center	Recreation	\$75.2 million	Financed through a 20-year bond with payback from a 1-cent sales tax. The tax revenues are split between the park district and the building project; Agreement with Williston State College (ARC is built on WSC land that was leased to them for 99 years for \$1)
Williston	Williston Basin International Airport (XWA)	Airport	\$274 million	\$106 million grant from FAA; \$55 million from state; \$112 million bonds to be supported by airport revenue
Williston	City of Williston Public Works Building	Building	\$30 million	Funded using 1-cent sales tax
Williston	Williston Public School District #1 Innovation Academy	Education	\$12 million	Williams County provided \$4 million grant; \$500,000 donation from American State Bank & Trust Company, ONEOK gave \$250,000; Equinor organized a free-will lunch that raised \$183,000. Williston Coyote Foundation is 501(c)3 raising funds; Funds are still being raised
Williston	Williston High School Relocation	Education	\$70 million	
Williston	Williston Parks Improvements	Recreation	\$7 million	Park district funding
Williston	Williston Water Resource Recovery Facility	Wastewater	\$125 million	State Revolving Loan Fund; Energy Infrastructure Impact Grant (\$2 million awarded in 2013); Special assessments; Bonds using sales tax to secure
Williston	Williston Landfill Expansion	Landfill	\$4.5 million	
Williston	Williston "Backbone" Infrastructure	Water, Wastewater, Roads	\$504 million	\$286 million in linear infrastructure improvements since 2006 and \$218 million in system expansions. Investments include \$23.8 million in water mains, 21.7 miles in new sewer, 33.8 miles of new street construction and renewal

Williston	Williston Fire Station Investments	Emergency	\$15 million	\$3.5 million renovation of station 1 in 2017, \$6 million new fire station on north side of city (2016), \$5.5 million new fire station for west side of city (2017); Public safety sales tax
Williston	Williston City Hall Renovation	Building	\$1.5 million	
Williston	Downtown Williston Upgrades	Housing	\$26.7 million	North Dakota Housing Finance Agency gave funds for affordable housing investments; Renaissance on Main was a combination of private and public funds. It used Renaissance Zone tax incentives and HIF funding in order to make a \$16 million investment in downtown Williston